United States
Department of
Agriculture

Economic
Research
Service

**International
Economics
Division**

A Japanese Grains Model

Michael Lopez

A JAPANESE GRAINS MODEL. By Michael Lopez. International Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 20005-4788. June 1986. ERS Staff Report No. AGES851003.

ABSTRACT

Japanese grain yields, areas, production, food demand, feed demand, trade, and government pricing policies are modeled on the basis of data mostly from 1965-79. Grains are classified into rice, wheat, corn, and other coarse grains, with the last often subdivided into barley and other grain. The model is then simulated through 1992, using as exogenous variables projections of Japanese population, Japanese real income, and U.S. grain prices (as proxies for world trade prices). The model's equations are designed for making 5- to 20-year projections, but alternative equations more suited to short-run policy analysis are also presented.

Keywords: Japan, model, projections, grain, rice, wheat, corn, barley, yield, area, production, food, feed, trade, price, policy

ABBREVIATIONS

GOL = Grains, Oilseeds, and Livestock model

MAF = Japanese Ministry of Agriculture and Forestry

MAFF = Japanese Ministry of Agriculture, Forestry and Fisheries (successor organization to MAF)

USDA = United States Department of Agriculture

FOREWORD

Japan, the world's largest net importer of agricultural products, is a stable market for about 20 percent of U.S. grain exports. Because the U.S. farm sector increasingly relies on exports, it has an interest in the agriculture, farm and trade policies, and general economic conditions of key foreign markets. In step with this growing concern, the USDA's Economic Research Service has expanded its coverage and analysis of Japan.

This report, a mathematical model of the Japanese grains economy, is part of a series of monographs and periodicals. Previous studies by William T. Coyle focused more on institutional aspects of the market in analyzing the trade impact of economic forces and policies. They include Japan's Rice Policy (1981) and Japan's Feed-Livestock Economy (1983). The current Japanese agricultural situation and policy environment are appraised in the annual East Asia and Oceania Outlook and Situation Report (released each May).

SUMMARY

This report documents the Japanese Grains Model, which portrays annual production, consumption, and trade of rice, wheat, corn, and other coarse grains. Based on model simulations, the principal conclusions are that the Japanese will have serious problems of rice overproduction, starting in the late eighties; and that by 1992 the country will be importing 28 to 30 million metric tons of coarse grains, plus nearly 6 million metric tons of wheat.

After introducing the background to the research, Chapter One presents the goals for this project, along with the strategy used to pursue them. Chapter Two describes the variables in the model and the statistical sources for their values. Chapters Three through Six go across a food balance sheet--food consumption, defined to include manufacture and waste; feed consumption; crop production and seed use; and "putting it all together" to obtain changes in stocks and net trade. Through Chapter Six, model estimations are based on the actual historical values of the relevant policy variables, which are treated as exogenous. In Chapter Seven, policies become endogenous; and model simulations are based on the estimated values of policy variables. Chapter Eight projects the remaining exogenous variables (population, gross national product, and world trade prices). Then it specifies three policy scenarios. Finally, it projects the complete model over the period 1983 to 1992 for each scenario.

A few stylistic guidelines may be helpful. This report is designed not to have to be read like a novel, from cover to cover; but instead to be readable like the Sunday edition of a city newspaper, with selective browsing based on the reader's interests. Although chapters may be read out of order, it makes sense to read at least Chapters Three through Five in sequence, so as to proceed from the very simple food sector of the model, to the less simple feed sector, to the complex crops sector. The report is extremely detailed, because one of its purposes is to allow other researchers and analysts to replicate, update, or modify the Japanese Grains Model. It is somewhat repetitious, because each chapter and most of the tables are designed to be nearly self-explanatory. As a saving grace, every chapter begins with a summary section. Hurried readers can obtain an annotated listing of all the model's equations by reading only the summaries. A fuller understanding of the reasoning behind the equations can be obtained from the main text, especially those sections titled "Modeling Approach". The last section of most chapters is a statistical appendix. Each such "Compendium of Regression Equations" serves both to illustrate the universe from which the regression equations in the model were selected, and to facilitate modifying the model for policy analysis. Roughly speaking, each summary section answers the question, "What is in the model?"; the main text answers "Why is it there?"; and each compendium of regression equations answers "Why isn't there something else instead?"

Almost all of this report should be understandable to readers with no training in economics. However, some technical jargon must be used to precisely convey details of the analysis to the author's professional colleagues, so that they can judge and hopefully improve this model.

Finally, tunnel-visioned seekers of the model's "bottom line" can turn directly to page 325, to find projections of Japanese net trade in rice, wheat, corn, and other coarse grains out to the year 1992.

ACKNOWLEDGMENTS

This work would not have been possible without the detailed advice and assistance given by William Coyle, the senior Japan specialist in the International Economics Division. William Kost, Jitendar Mann, and Karen Liu (of the same division) reviewed drafts of this report, making many useful suggestions. Editors Raymond Bridge and Mary Maher (of the Information Division) combined skill with mercy while pruning the manuscript.

The U.S. Agricultural Counselor's Office in Tokyo helped in many ways: by furnishing statistical yearbooks, journals, and their own report series; by answering the author's questions concerning Japanese statistics; and by providing information to the author during his visit to Tokyo in December 1983. William Davis, the Agricultural Counselor, and members of his staff--especially Suzanne Hale and Sadao Suzuki--were helpful and gracious hosts. They arranged visits to the Japanese Ministry of Agriculture, Forestry and Fisheries, where the author spoke with the personnel who prepare the food balance sheets that furnish the central data for this study; to the Japanese National Research Institute of Agricultural Economics, where the author conferred with Keiji Oga and Masaru Kagatsume; and to the Tokyo office of the U.S. Feedgrains Council, where the author talked with Henry Thomason, Seiji Terada, and Koichi Ito.

Colleagues at the USDA Washington headquarters assisted in their various areas of expertise: George Hoffman explained feeding practices; Tom Lutton advised on the econometrics of logit and multinomial logit estimation; Roger Lewis and Susie Wu translated passages of Japanese text. Lois Caplan helped the author track down Japanese data and compiled the monthly consumer price index series shown in Table 2.8.

All graphs were prepared by Barbara Barnes, who cheerfully put up with many requests for revision--and even had to be restrained from spending too much of her time perfecting the graphs to her standards, which exceed the author's.

Thelma Carpenter keypunched most of the data cards used for model estimation. Charles Hallahan, Linda Atkinson, Linda Tompkins, and Don Sillers helped the author with the computer analysis.

Rhodia Ewell, Marie Kemp, and Angela Roberts typed substantial portions of this report. Tracie Burnette, Peggy McConkey, Linda Mitchell, Becky Pearson, Connie Presley, Pat Thomas, and Sharon Yun also contributed to document preparation.

The author, of course, is responsible for the errors which remain despite the extensive help received, from those mentioned here and from others unnamed.

TABLE OF CONTENTS

		Page
I	INTRODUCTION	1
	SUMMARY	1
	BACKGROUND	1
	MODEL GOALS	2
	NOTES FOR CHAPTER ONE	4
II	VARIABLES	5
	SUMMARY	5
	CHOICE OF COMMODITIES	6
	DATA SOURCES AND DEFINITIONS	6
	General Principles	6
	Bibliography of Main Sources	7
	Documentation for Each Variable	7
	Food Balance Sheet Variables	8
	Area and Yield	8
	Price Variables and the Rice Diversion Payment	15
	Population	23
	Income	23
	Other Variables	23
	GRAPHS OF EXPLANATORY VARIABLES	31
	NOTES FOR CHAPTER TWO	34
III	FOOD	37
	SUMMARY	37
	REVIEW OF DATA	38
	MODELING APPROACH	41
	RICE	42
	WHEAT	44
	BARLEY	46
	The Special Nature of Barley Consumption	46
	Direct Barley Use	46
	Industrial Barley Use	50
	Total Barley Food Use	52
	CORN	52
	OTHER GRAIN	55
	COMPENDIUM OF FOOD DEMAND REGRESSION EQUATIONS	55
	NOTES FOR CHAPTER THREE	68
IV	FEED	70
	SUMMARY	70
	REVIEW OF DATA	71
	MODELING APPROACH	74
	TOTAL GRAIN USED AS FEED	78
	WHEAT FEED VERSUS NON-WHEAT FEED	81
	OTHER COARSE GRAINS FEED VERSUS RICE PLUS CORN FEED	86
	RICE FEED AND CORN FEED	89
	COMPENDIUM OF FEED DEMAND REGRESSION EQUATIONS	93
	NOTES FOR CHAPTER FOUR	100

Page

V CROPS 101

SUMMARY 101
Modeling Approach 101
Definitions of Explanatory Variables 101
Yields 104
Areas 104
Quantities Supplied 106
Seed Used 107
Production Net of Seed Used 107
REVIEW OF DATA 109
MODELING APPROACH FOR CROPS 109
YIELDS 113
Modeling Approach for Yields 113
Rice Yield 114
Wheat Yield 114
Barley Yield 116
AREAS 117
Special Explanatory Variables for Areas 117
Expected Revenue from Crops 117
Expected Revenue from Off-Farm Employment 127
Expected Revenue from the Rice Diversion Payment 127
Total Area 128
Allocation of Total Area to Individual Crops 130
Rice Area versus Nonrice Area 130
Wheat Plus Barley Area versus Other Nonrice Area 133
Wheat Area versus Barley Area 136
QUANTITIES SUPPLIED 137
SEED USED 146
PRODUCTION NET OF SEED USED 147
Major Grain Crops: Rice, Wheat, and Barley 147
Minor Grain Crops: Corn and Other Grain 147
COMPENDIUM OF CROP REGRESSION EQUATIONS 157
Yields 157
Areas 157
Seed Used 169
NOTES FOR CHAPTER FIVE 180

VI PUTTING IT ALL TOGETHER: FOOD BALANCE RELATIONSHIPS 182

SUMMARY 182
REVIEW OF DATA ON CHANGES IN STOCKS AND ON NET TRADE 183
MODELING APPROACH 183
RICE 185
NONRICE GRAINS 186
REGRESSIONS FOR ADDITIONS TO STOCKS 187
REGRESSIONS FOR NET TRADE 203
NOTES FOR CHAPTER SIX 208

Page

VII POLICIES 209

SUMMARY 209
REVIEW OF DATA 212
INSTITUTIONAL BACKGROUND 212
MODELING APPROACH 214
RICE SUPPLY PRICE 217
WHEAT AND BARLEY SUPPLY PRICES 218
RICE DIVERSION PAYMENT 222
DISPOSAL OF SURPLUS RICE 225
Total of Rice Feed Plus Exports 225
Allocation between Feed and Exports 228
COMPLETE MODEL SIMULATION FROM 1969 THROUGH 1979 230
COMPENDIUM OF POLICY REGRESSION EQUATIONS 259
NOTES FOR CHAPTER SEVEN 269

VIII PROJECTIONS TO 1992 272

SUMMARY 272
Projections of Exogenous Variables 272
Assumptions for Policy Variables and New Policy Equations 272
Projections of Endogenous Variables 275
REVIEW OF RECENT DATA 276
PROJECTED VALUES OF EXOGENOUS VARIABLES 280
ASSUMPTIONS FOR POLICY VARIABLES 287
General Assumptions 287
"Surplus Management" Scenario 292
"Constant Prices" Scenario 292
"Budget Squeeze" Scenario 292
PROJECTED VALUES OF ENDOGENOUS VARIABLES 293
Supply Prices, Yields, and Expected Revenues 293
Rice Diversion Payments 293
Food Demand 294
Feed Demand 294
Areas and Production 315
Excess Rice Production and the Disposal of Surplus Rice 335
Net Trade 335
APPROACHES TO REDUCING EXCESS RICE PRODUCTION 336
NOTES FOR CHAPTER EIGHT 339

A Japanese Grains Model

Michael Lopez

CHAPTER ONE

INTRODUCTION

SUMMARY

The Japanese Grains Model depicts the annual production, consumption, and trade of rice, wheat, corn, and other coarse grains. It is constructed so that it can either run by itself, or else run linked to the USDA's world Grains, Oilseeds, and Livestock Model.

The model is designed primarily for making medium- to long-range projections (5 to 20 years), and secondarily for policy analysis. However, two features make it relatively easy to customize the model to analyze specific policy issues: its modular structure, which allows parts of it to be changed while the rest stays intact; and the presentation in this report of many alternative regression equations, which can substitute as "spare parts". General goals for the model are that every aspect of it make sense, that the estimates it provides accurately reflect recent history, that its calculations be verifiable, that its scope be wide enough for it to address many questions, that its structure be both maintainable and flexible, and finally that the model as a whole be understandable. The strategy used to pursue these goals includes extremely detailed documentation, as well as the above-mentioned modular structure and presentation of alternate equations.

BACKGROUND

The Japanese Grains Model has been developed in the context of the preparation of the revised USDA worldwide Grains, Oilseeds, and Livestock Products (GOL) Model. 1/* The revised GOL Model is designed to simulate annual production, food consumption, feed consumption, trade, and prices for 19 commodities until the year 2000, and to evaluate the effects of alternative policies on these variables. The United States component for the revised GOL Model is complete; Japan is one of several regions whose revised GOL Model components are now in various stages of preparation. 2/

---

* Underlined numbers refer to notes at the end of each chapter.

MODEL GOALS

Some generally desirable characteristics for a model are as follows:

First, it should make sense. For instance, the demand for a commodity should fall when its price rises. Some common sense requirements are less clear-cut than sign rules: for example, a judgment is needed on whether a regression equation implies an implausibly high level of consumption in the future.

A model should be accurate. Of course, the accuracy of a model's projections for future years cannot be determined at the time the model is made; and the accuracy of counterfactual "what if" scenarios never can be determined. Usually the best that can be done is to validate individual regressions by examining their analytic statistics (such as standard errors), and to validate the model as a whole by examining how well its equations acting together track historical data.

It is helpful if a model has a wide scope: that is, if it can provide answers to a large number of questions. The GOL Model, for example, is designed not only to project the most likely outcomes for various commodities, but also to enable analysis of the effects of alternative trade and price-support policies.

A model ought to be replicable: that is, other researchers should be able to start with the same data and reach the same conclusions. Although this requirement seems trivial, in practice many--probably the great majority--of published models in the social sciences are insufficiently documented to be replicable. 3/

A projections model should be maintainable. In the contrary case, a projections model which cannot be updated on a regular basis soon becomes useless. It is desirable that the process of updating the model be relatively simple and inexpensive. It is not desirable to have a situation in which only the person who wrote the model knows how to maintain it.

Hopefully, a model will be understandable. Sometimes the situation being modeled is so complicated that it can be adequately represented only by a tangled set of simultaneous equations, interacting with a very complex logic. But when it is possible to present a model so that its inner logic is clearly expressed, this allows users and critics to appreciate the model's strengths and weaknesses--and perhaps to improve it.

It is advantageous if a model is flexible--that is, if parts of it can be altered without having to rewrite almost all of it. Then as time goes on, new developments can be incorporated into the model's structure, or the scope of the model can be widened, without great effort.

In addition to the general goals just described, a specific objective for the Japanese Grains Model is that it either can be merged into the world GOL Model, or else be run independently.

The general and specific objectives of the model have been implemented as follows:

The Japanese Grains Model, like the GOL Model, analyzes annual figures at the national level. Thus variations within a year, or differences between regions within Japan, are ignored.

The variables in the model all pertain to grains, except for a few general series like income and population. These variables have been selected so that the model can either run by itself (making projections to 1992), or else run as a component of the GOL Model (making projections to 2000).

Equations violating common-sense requirements have been excluded from the model, no matter how alluring their regression statistics.

The primary goal of the model is to project what is most likely to happen to Japanese production, consumption, and net trade in grains over the next 5 to 10 years. Thus the highest adjusted R^2 statistic has usually determined the choice among equations which do not violate common-sense restrictions.

When additional policy analysis can be accommodated at a small sacrifice in adjusted R^2, this is done (notably in the feed sector). But most conflicts between accuracy and scope have been resolved through model flexibility. Thus a "best" equation is used to make projections; but alternative equations are also presented, which can serve to analyze a range of policy questions, and which can easily be substituted for the "best" equation. Like a suit with long pants and wide hems, the model contains extra material so that it may be altered to fit the user's needs. (This issue is discussed in greater detail in Chapter Three.)

Extraordinarily thorough documentation is used to further the goals of understandability, replicability, maintainability, and scope. This report presents every number in the original dataset, as well as the source for each figure; it presents every equation used in the model, as well as many alternative equations tailored to analyze particular policy issues. A copy of the computer instructions required to process, file, print, and plot the raw data; to estimate the regression equations; and to simulate, print, and plot the Japanese Grains Model as a whole, is available from the author. These computer programs are largely self-documented, as are the "SAS" data files which they produce.

The model is organized in blocks, such as Food Use and Feed Use. This structure enhances the model's flexibility--a block usually can be altered without changing other blocks--and makes the model more understandable.

To facilitate replicability and maintainability, the data underlying nearly every variable in the model have been obtained from sources which should continue to be published regularly, such as government yearbooks. (For the early years of some time series, however, data could be obtained only from obscure sources, as explained in Chapter Two.)

NOTES FOR CHAPTER ONE

1/ The original GOL Model was published under the title Alternative Futures for World Food in 1985: Vols. I-III, by Anthony Rojko and others (Foreign Agricultural Economic Reports 146, 149, 151; Economics, Statistics, and Cooperatives Service, U.S. Dept. of Agriculture; 1978). A detailed but partial description of the revised model is given by Vernon O. Roningen and Karen Liu, in The World Grain, Oilseeds, and Livestock (GOL) Model - Background and Standard Components (ERS Staff Report AGES830317, Economic Research Service, U.S. Dept. of Agriculture, April 1983), and in The World Grain-Oilseeds-Livestock (GOL) Model, a Simplified Version (ERS Staff Report AGES850128, Economic Research Service, U.S. Dept. of Agriculture, February 1985).

2/ A "JPGOL" model, developed in parallel to this one, is documented in Karen Liu, A Grains, Oilseeds, and Livestock Model of Japan (ERS Staff Report AGES850627, Economic Research Service, U.S. Department of Agriculture, August 1985). The JPGOL model includes more commodities than the Japanese Grains Model and is optimized to be consistent with the world GOL model. On the other hand, the Japanese Grains Model is optimized to be consistent with Japanese agricultural institutions.

3/ For example, in analyzing twenty forecasting models that had been published in agricultural economics journals, Dennis L. Meadows found that less than 20 percent were documented sufficiently to permit independent verification of the published results. (Meadows, personal communication to the author, May 1982.)

CHAPTER TWO

VARIABLES

SUMMARY

The commodities analyzed in the Japanese Grains Model are rice, wheat, barley, corn, and other grain. To link up to the USDA's global Grain, Oilseeds, and Livestock Model, barley is combined with other grain, forming the GOL category other coarse grains.

Although regression equations in the model typically are based on data from 1965-79, when possible the time series for each variable has been extended back to 1960. International trade prices and one of two consumer price index series are in calendar years. All other variables are in Japanese fiscal years. Fiscal 1979, for example, runs from April 1, 1979 through March 31, 1980.

When sources of data for the model's variables were selected, the goals were accuracy, verifiability, and ease of keeping the model up to date. For these reasons, the data for almost every variable are taken from government statistical yearbooks or monthly bulletins, at least for recent years.

The basic quantity data come from the food balance sheets published in the Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries, and in the agriculture ministry's revised Food Balance Sheets: 1955-1966. Food demand, as defined for this model, comprises the Japanese food balance sheet categories "Gross Food", "Industrial Use", and "Waste". The net quantity traded is defined as exports minus imports. The remaining food balance items in the model are the quantity supplied from domestic production, the quantity used as seed, the quantity used as feed, and the quantity added to stocks.

Statistics on gross total area, net total area, and the areas planted to rice, wheat, and barley, are taken from the agriculture ministry's Statistical Yearbook and Abstract of Statistics.

All prices are converted into 1970 yen using consumer price index statistics from the Japan Statistical Yearbook, published by the Prime Minister's Office. The International Monetary Fund's International Financial Statistics Yearbook provides trade price data for rice (f.o.b. Bangkok), wheat (f.o.b. Gulf ports), and maize (f.o.b. Gulf ports). Sorghum prices (f.o.b. Gulf ports), representing the other coarse grains category, come from the dataset which underlies trade prices reported in the USDA's monthly Agricultural Outlook. All trade prices are converted into yen per kilogram using a yen-per-dollar exchange rate published in the International Financial Statistics Yearbook and weight conversion factors printed in the Japanese agriculture ministry's Statistical Yearbook. Demand prices for rice, wheat, and barley are defined as the official wholesale-level "resale price" maintained by the Japanese Food Agency. Resale prices for the 1970's are obtained from the Statistical Yearbook; resale prices for the 1960's are obtained from an Australian Bureau of Agricultural Economics study on Japanese Agricultural Policies, and from U.S. agricultural attaché reports collected by William T. Coyle. The supply prices for rice, wheat, and barley are measured by the Japanese Food Agency's official purchase prices, as published in the

Statistical Yearbook. Japanese farmers receive so-called diversion payments to grow anything other than rice; data on the size of these payments is taken from Coyle's monograph on Japan's Rice Policy. For corn and for other grain, in which there is essentially free trade, the model equates the demand price to the trade price. The model does not use supply prices of corn or other grain, since Japanese production of these crops is so small.

Statistics on population and on gross national product (GNP) come from the Japan Statistical Yearbook. The GNP statistics in billions of current yen are divided by the population and by the consumer price index, yielding GNP in thousands of 1970 yen per capita.

CHOICE OF COMMODITIES

The selection of variables for the Japanese Grains Model is related to the data available. In order to link up to the rest of GOL, the grains model has to predict net trade in the four standard GOL grain commodities: rice, wheat, corn, and other coarse grains. However, in Japan the three main cereals grown are rice, wheat, and barley (in that order of importance); scarcely any corn is produced. The most important source of data, the Japanese food balance sheets, do not distinguish corn from other cereals before 1972. Furthermore, it was considered important to produce a model which would be relevant and helpful for Japanese situation and outlook analysis. Therefore the model includes rice, wheat, barley, corn, and "other grain" (defined as total cereals minus the four grains specified). To link up to the rest of GOL, barley is added to other grain, with the result equal to the GOL category other coarse grains.

A few technical notes about commodity coverage are necessary. Japanese rice statistics are given on a brown basis. 1/ One ton of brown rice approximately equals 0.91 ton of milled rice. 2/ All barley quantities in the model are the sum of the Japanese statistics for "barley" and "naked barley".

DATA SOURCES AND DEFINITIONS

General Principles

Whenever possible, the data used to estimate the model were collected from government periodicals. Official Japanese statistics are the most accurate available for that country, and gathering data from readily available yearbooks and monthly bulletins makes it easier to update the model on an annual basis. Moreover, this provides the model with a publicly verifiable data base. Although almost all recent statistics come from government publications, 3/ data for early years sometimes could be found only in obscure sources, as documented below.

When possible, statistics were collected back to the year 1960; in all cases, they were collected through 1979. Regressions were usually run for the 15-year span 1965-79. Unless otherwise specified, data are for Japanese fiscal years (JFY) beginning on April 1. Fiscal 1979, for example, ran from April 1, 1979 through March 31, 1980.

Bibliography of Main Sources

Almost all statistics are derived from a few sources, listed here in approximate order of importance.

The primary sources are publications of the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF), which was called the Ministry of Agriculture and Forestry (MAF) until July 1978. The Statistical Yearbook of the Ministry of Agriculture, Forestry and Fisheries has been bilingual in Japanese and English since the fiscal-year 1973/74 edition. A convenient source for earlier years is the MAF Abstract of Statistics on Agriculture, Forestry and Fisheries, which reprints in English the most important information from the yearbook. MAF issued a set of revised Food Balance Sheets: 1955-1966 in September 1968.

Statistics on population, the consumer price index, and national accounts, such as the gross national product, are obtained from the bilingual Japan Statistical Yearbook, published by the Prime Minister's Office. The most recent data come from the bilingual Monthly Statistics of Japan, also published by the Prime Minister's Office.

Data on trade prices and international exchange rates are obtained from the International Monetary Fund's International Financial Statistics Yearbook.

A general introduction to Japanese agriculture is outside the scope of this report. Readers would be well served by any of the following publications:

William T. Coyle, Japan's Rice Policy, Foreign Agricultural Economic Report 164, Economics and Statistics Service, U.S. Department of Agriculture, July 1981. (This document provides the model's statistics on diversion payments.)

William T. Coyle, Japan's Feed-Livestock Economy: Prospects for the 1980's, Foreign Agricultural Economic Report 177, Economic Research Service, U.S. Department of Agriculture, February 1983.

I.M. Roberts, R.A. Bain, and E.A. Saxon, Japanese Agricultural Policies: Their Origins, Nature and Effects on Production and Trade, Policy Monograph No. 1, Bureau of Agricultural Economics, Government of Australia, 1981. (Part of the information used to calculate barley demand prices comes from this source.)

Fred H. Sanderson, Japan's Food Prospects and Policies, Washington: the Brookings Institution, 1978.

Documentation for Each Variable

This section seeks to document each variable thoroughly enough to allow replicating and updating the model's database. For these purposes, data sources must be described in minute detail, fascinating only to collectors of Japanese statistics. Others should skim shamelessly.

Food Balance Sheet Variables

Food balance sheets published by the Japanese agriculture ministry provide not only the quantity data for the model, but also its analytical framework: the model is organized as the explanation of each item in a food balance table.

The MAF Food Balance Sheets: 1955-1966 and the MAF/MAFF statistical yearbooks furnish quantity data measured in thousand metric tons. For modeling purposes, the quantity traded is defined as exports minus imports, and the quantity used as food comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste". The remaining items are taken from food balance sheets without modification. The following accounting relationships hold:

$$QS - QZ = QT + QA + QF + QD$$

$$QT = QX - QM$$

where:

QS = quantity supplied = domestic production

QZ = quantity used as seed

QT = quantity traded, measured as net exports

QA = quantity added to stocks

QF = quantity used as feed

QD = quantity demanded = quantity used as food

QX = quantity exported

QM = quantity imported

It appears that the gross food component of the official food balance sheets is a residual category which allows them to balance exactly, and that waste is calculated as a predetermined fraction of gross food. 4/

Tables 2.1 through 2.5 show the food balance sheet data as rearranged for the Japanese Grains Model. Table 2.6 shows the feed use of corn plus other grain during 1960-71, when the food balance sheets do not list corn separately.

Area and Yield

Area statistics for rice, wheat, and barley over 1968-79 are taken from time series published in the MAF/MAFF Statistical Yearbook; earlier statistics are taken from the Abstract of Statistics. All area statistics are expressed in thousands of hectares. Because the peak of the harvest occurs near the midpoint of the Japanese fiscal year, calendar-year data coincide with fiscal-year data. 5/

Yields for rice, wheat, and barley are calculated as production divided by area. 6/

--Text continues to page 15.

Table 2.1--Food balance sheet for rice

Fiscal year	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food
	Thousand metric tons, brown basis							
1960	12,858	104	219	0	-219	459	20	12,494
1961	12,419	101	77	0	-77	-566	20	12,941
1962	13,009	98	182	0	-182	-124	20	13,197
1963	12,812	101	239	0	-239	-359	32	13,277
1964	12,584	101	502	0	-502	-275	20	13,240
1965	12,409	101	1,052	0	-1,052	468	20	12,872
1966	12,745	103	679	0	-679	921	28	12,372
1967	14,453	103	364	0	-364	2,334	26	12,354
1968	14,449	104	265	35	-230	2,428	26	12,121
1969	14,003	105	48	440	392	1,646	26	11,834
1970	12,689	99	15	785	770	-281	274	11,827
1971	10,887	93	10	859	849	-3,295	1,490	11,750
1972	11,889	94	1	459	458	-1,670	1,265	11,742
1973	12,149	91	38	430	392	-801	496	11,971
1974	12,292	93	63	271	208	51	13	11,927
1975	13,165	96	29	2	-27	1,228	10	11,858
1976	11,772	98	18	3	-15	-32	12	11,709
1977	13,095	97	71	100	29	1,583	9	11,377
1978	12,589	92	45	1	-44	1,269	8	11,264
1979	11,958	90	20	868	848	-108	7	11,121

Note: One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see notes 1 and 2 on page 34 for details.

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966. The "Quantity used as food" comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste".

Table 2.2--Food balance sheet for wheat

Fiscal year	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food
				Thousand metric tons				
1960	1,531	40	2,660	47	-2,613	179	468	3,457
1961	1,781	43	2,660	71	-2,589	180	616	3,531
1962	1,631	38	2,490	93	-2,397	-244	646	3,588
1963	716	31	3,412	73	-3,339	-235	520	3,739
1964	1,244	27	3,471	68	-3,403	142	534	3,944
1965	1,287	26	3,532	88	-3,444	100	530	4,075
1966	1,024	22	4,103	79	-4,024	65	543	4,418
1967	997	24	4,238	87	-4,151	42	592	4,490
1968	1,012	22	3,996	114	-3,882	-198	567	4,503
1969	758	17	4,537	81	-4,456	-31	667	4,561
1970	474	11	4,621	47	-4,574	-159	701	4,495
1971	440	9	4,726	55	-4,671	-95	632	4,565
1972	284	6	5,269	57	-5,212	173	707	4,610
1973	202	5	5,369	38	-5,331	35	708	4,785
1974	232	8	5,485	26	-5,459	174	619	4,890
1975	241	9	5,715	34	-5,681	344	590	4,979
1976	222	8	5,545	44	-5,501	63	576	5,076
1977	236	10	5,662	4	-5,658	133	637	5,114
1978	367	14	5,679	2	-5,677	183	669	5,178
1979	541	21	5,544	4	-5,540	61	683	5,316

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966. The "Quantity used as food" comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste".

Table 2.3--Food balance sheet for barley

Fiscal year	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food	Industrial food use
	Thousand metric tons								
1960	2,301	42	30	1	-29	189	540	1,559	210
1961	1,976	37	0	0	0	-254	981	1,212	257
1962	1,726	35	0	1	1	-251	836	1,105	290
1963	759	27	414	1	-413	-317	497	965	289
1964	1,202	23	580	0	-580	64	648	1,047	355
1965	1,234	20	512	0	-512	58	665	1,003	354
1966	1,105	19	598	0	-598	-4	693	995	375
1967	1,032	22	666	2	-664	-43	737	980	380
1968	1,021	18	777	2	-775	84	738	956	412
1969	812	14	806	2	-804	-93	785	910	483
1970	573	10	1,072	2	-1,070	-42	862	813	507
1971	503	8	1,138	0	-1,138	-105	898	840	517
1972	324	5	1,481	1	-1,480	-30	982	847	583
1973	216	5	1,817	0	-1,817	-93	1,133	988	669
1974	233	5	2,038	0	-2,038	139	1,129	998	699
1975	221	6	2,117	0	-2,117	143	1,176	1,013	719
1976	210	5	2,258	0	-2,258	215	1,238	1,010	732
1977	206	5	2,238	0	-2,238	92	1,288	1,059	792
1978	326	8	2,052	0	-2,052	-2	1,325	1,047	855
1979	407	11	2,132	0	-2,132	77	1,420	1,031	864

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966. The "Quantity used as food" comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste".

Table 2.4--Food balance sheet for corn

Fiscal year	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food
	Thousand metric tons							
1972	23	0	6,364	0	-6,364	-84	5,276	1,195
1973	17	2	8,021	0	-8,021	666	6,142	1,228
1974	14	2	7,719	0	-7,719	-30	6,349	1,412
1975	14	2	7,568	0	-7,568	-47	6,263	1,364
1976	12	2	8,612	0	-8,612	45	6,841	1,736
1977	8	2	9,313	0	-9,313	-114	7,578	1,855
1978	7	2	10,736	0	-10,736	260	8,486	1,995
1979	5	1	11,707	0	-11,707	371	9,256	2,084

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions. The "Quantity used as food" comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste". Corrections to the figures published in the 1977 food balance sheet for additions to stocks (-114 instead of +597) and for industrial use (1,679 instead of 968) were furnished by William L. Davis, Agricultural Counselor, American Embassy, Tokyo, on the basis of conversations with MAFF officials (personal correspondence to William T. Coyle and the author, February 17, 1983).

Table 2.5--Food balance sheet for other grain

Fiscal year	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food
					Thousand metric tons			
1972	85	3	3,909	0	-3,909	-131	4,029	93
1973	74	3	4,359	0	-4,359	260	4,065	105
1974	67	2	4,617	0	-4,617	-4	4,607	79
1975	52	5	3,993	0	-3,993	-155	4,102	93
1976	39	2	4,987	0	-4,987	49	4,866	109
1977	40	1	5,425	0	-5,425	-14	5,376	102
1978	47	1	5,388	0	-5,388	-60	5,376	118
1979	38	2	5,900	0	-5,900	-3	5,807	132

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions. The "Quantity used as food" comprises the food balance sheet categories "Gross Food", "Industrial Use", and "Waste".

Table 2.6--Feed use of corn plus other grain, 1960 to 1971

Fiscal year	Quantity used as feed
	Thousand metric tons
1960	1,739
1961	2,374
1962	2,872
1963	3,637
1964	4,004
1965	4,712
1966	5,827
1967	6,017
1968	6,649
1969	7,416
1970	8,939
1971	8,174

Sources: Japan, Ministry of Agriculture and Forestry, Statistical Yearbook, pages 402-403 in the 1971/72 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966.

The Statistical Yearbook and Abstract of Statistics also provide data on the (net) total area of cultivated land throughout Japan for all crops, including non-grains; and on the (gross) total area planted to all crops, including non-grains. The difference between these two sets of figures is that double-cropped land is counted once in the net figures and twice in the gross figures.

Table 2.7 summarizes the area and yield statistics used in the model. Because Japanese production of corn and of other grain is so small, the model does not use data on areas and yields for these crops.

Price Variables and the Rice Diversion Payment

Price Deflator. The consumer price index (CPI) is used as the price deflator throughout the model. Only one price adjustor is used, to simplify the task of making projections. The consumer price index was chosen primarily because it is a familiar concept. Other deflators, such as the implicit gross national product deflator, would have worked just as well.

Monthly CPI data collected from various issues of the Japan Statistical Yearbook were converted to a common base year and aggregated into fiscal-year and calendar-year averages. Table 2.8 reproduces the original monthly data and Table 2.9 shows the transformed annual statistics. Almost all price-related variables in the model are on a fiscal-year basis, and are therefore deflated by the fiscal-year CPI series. International trade prices, however, are on a calendar-year basis, and are therefore deflated by the calendar-year CPI.

Trade Prices. Trade prices were collected with the objective of obtaining a standard international trade price at the export level. Prices for rice (f.o.b. Bangkok), wheat (f.o.b. U.S. Gulf ports), and corn (f.o.b. U.S. Gulf ports) come from the International Financial Statistics Yearbook of the International Monetary Fund. 7/ To represent the category other coarse grains, the price of sorghum (f.o.b. U.S. Gulf ports) is taken from a U.S. Department of Agriculture database. All of these prices are first transformed into dollars per metric ton, using appropriate conversion factors, and then converted into yen per kilogram, using exchange rates taken from the International Financial Statistics Yearbook. Finally, the calendar-year CPI series from Table 2.9 is used to adjust the trade prices into 1970 yen per kilogram. Table 2.10 shows trade prices in their original units, such as dollars per bushel; Table 2.11 shows the trade prices converted to dollars per metric ton, as well as the yen-per-dollar exchange rate; and Table 2.12 shows the trade prices both in current yen per metric ton and in 1970 yen per metric ton.

Demand Prices. The government, acting through the Japanese Food Agency, is the dominant purchaser of rice, wheat, and barley, which it buys from farmers and farmers' cooperatives, and then resells at the wholesale level. Both the purchase prices and the resale prices are fixed as a matter of policy. Since the Food Agency also controls the imports of these cereals and maintains stockpiles, it is able to enforce its pricing decisions--the Japanese price of rice in recent years, for example, has been held at about three times the world-market level.

--Text continues to page 22.

Table 2.7--Areas and yields

Year	Rice area	Wheat area	Barley area	Net total area cultivated	Gross total area planted	Rice yield	Wheat yield	Barley yield
	Thousand hectares					Metric tons per hectare		
1960	3,308	602.0	838.0	6,071	--	3.89	2.54	2.75
1961	3,301	649.0	692.0	6,086	8,071	3.76	2.74	2.86
1962	3,285	642.0	613.0	6,081	7,999	3.96	2.54	2.82
1963	3,272	584.0	566.0	6,060	7,813	3.92	1.23	1.34
1964	3,260	508.0	479.0	6,042	7,619	3.86	2.45	2.51
1965	3,255	476.0	422.0	6,004	7,430	3.81	2.70	2.92
1966	3,254	421.0	388.0	5,996	7,312	3.92	2.43	2.85
1967	3,263	367.0	352.0	5,938	7,112	4.43	2.72	2.93
1968	3,280	322.4	315.9	5,897	6,979	4.41	3.14	3.23
1969	3,274	286.5	283.1	5,852	6,809	4.28	2.65	2.87
1970	2,923	229.2	225.8	5,796	6,311	4.34	2.07	2.54
1971	2,695	166.3	163.4	5,741	6,001	4.04	2.65	3.08
1972	2,640	113.7	121.2	5,683	5,812	4.50	2.50	2.67
1973	2,620	74.9	80.0	5,647	5,663	4.64	2.70	2.70
1974	2,724	82.8	77.5	5,615	5,752	4.51	2.80	3.01
1975	2,764	89.6	78.1	5,572	5,755	4.76	2.69	2.83
1976	2,779	89.1	80.3	5,536	5,730	4.24	2.49	2.62
1977	2,757	86.0	77.8	5,515	5,707	4.75	2.74	2.65
1978	2,548	112.0	96.1	5,494	5,656	4.94	3.28	3.39
1979	2,497	149.0	115.6	5,474	5,662	4.79	3.63	3.52

Notes:

In this context, data for calendar, fiscal, and crop years are the same.

Yield figures shown here, unlike those used in model estimation, are rounded.

Sources (with MAF = Ministry of Agriculture and Forestry; MAFF = Ministry of Agriculture, Forestry and Fisheries):

Rice, wheat, and barley areas: Japan, MAF/MAFF, Statistical Yearbook, pages 100-106 in the 1979/80 edition and the equivalent table in earlier editions; MAF, Abstract of Statistics, page 15 in the 1968 edition and page 7 in the 1966 edition.

Net total area cultivated: Japan, MAF/MAFF, Statistical Yearbook, page 78 in the 1979/80 edition and the equivalent table in earlier editions; MAF, Abstract of Statistics, page 11 in the 1968 edition and page 2 in the 1966 edition.

Gross total area planted: Japan, MAF/MAFF, Statistical Yearbook, page 140 in the 1979/80 edition and the equivalent table in earlier editions; MAF, Abstract of Statistics, page 21 in the 1968 edition and page 13 in the 1966 edition.

Rice, wheat, and barley yields: Calculated as the "Quantity supplied" reported in Table 2.1, 2.2, or 2.3, divided by the area reported in this table.

Table 2.8--Consumer price indices (original data)

Fiscal year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
1960/61	99.2	100.1	99.7	99.6	101.4	101.2	101.7	101.3	101.1	102.5	103.0	102.8
1961/62	103.8	103.3	103.3	105.0	105.8	106.4	108.7	109.2	110.2	110.9	110.5	110.7
1962/63	111.9	112.5	112.1	113.2	113.2	112.8	113.7	113.3	115.6	117.5	118.4	119.3
1963/64	120.2	121.1	122.2	122.6	121.0	123.0	122.6	121.8	122.4	122.2	122.3	122.8
1964/65	124.6	125.3	125.3	124.9	126.4	127.0	129.7	128.1	128.5	97.9	97.7	98.3
1965/66	100.7	99.8	99.6	99.2	99.7	101.2	102.5	101.5	102.1	103.1	103.9	104.3
1966/67	105.5	104.8	105.0	105.3	104.5	105.7	106.4	105.6	106.6	107.8	108.3	108.5
1967/68	108.8	108.1	107.5	107.4	108.3	110.0	111.9	111.8	112.6	113.5	114.0	114.2
1968/69	114.5	114.5	113.5	113.5	114.5	117.1	117.2	117.5	117.0	117.4	117.4	118.7
1969/70	120.0	120.0	120.2	121.9	122.9	123.8	124.4	123.8	124.6	126.5	127.4	128.4
1970/71	129.8	129.0	128.3	129.2	129.8	132.7	134.9	134.4	134.8	103.9	103.9	104.0
1971/72	105.5	105.6	106.0	105.8	105.7	108.6	108.8	107.7	107.7	107.8	108.2	109.2
1972/73	110.3	110.7	110.7	110.7	111.6	112.2	113.0	112.5	113.4	114.5	115.4	118.4
1973/74	120.7	122.8	123.0	123.9	125.0	128.6	129.1	130.4	135.1	141.0	145.8	146.8
1974/75	150.8	151.2	152.0	155.1	156.7	159.2	162.9	164.0	164.7	165.5	166.0	167.6
1975/76	171.3	172.5	172.4	172.8	172.4	175.6	178.5	177.3	177.2	105.0	105.6	106.0
1976/77	108.6	108.9	109.1	109.7	108.8	111.7	112.4	112.4	113.6	114.7	115.3	116.0
1977/78	117.9	119.0	118.4	118.1	118.1	120.2	120.8	119.4	119.1	119.6	120.1	121.2
1978/79	122.5	123.2	122.5	123.0	123.1	124.6	124.8	123.5	123.3	123.4	123.0	124.0
1979/80	125.7	127.0	127.1	128.2	126.9	128.5	130.1	129.6	130.4	131.6	132.8	133.9

Period included	Coverage	Calendar-year base	Multiply by this factor to convert to calendar-year 1975 = 100	
January 1960 to December 1965	"All cities"	1960 = 100	0.332	(All these conversion factors are taken from the 1980 edition of the Japan Statistical Yearbook, page 380.)
January 1966 to December 1970	"All Japan"	1965 = 100	0.445	
January 1971 to December 1975	"All Japan"	1970 = 100	0.580	
January 1976 to March 1980	"All Japan"	1975 = 100	1.000	

Sources: Japan, Prime Minister's Office, Japan Statistical Yearbook, page 380 in the 1980 edition and the equivalent table in earlier editions; and its Monthly Bulletin of Statistics, April 1981, page 95.

Table 2.9--Consumer price indices
(as used in the model)

Year	Consumer price index for calendar year	Consumer price index for fiscal year
	Calendar 1970 = 1	Calendar 1975 = 100
1960	0.566	33.53
1961	0.596	35.62
1962	0.637	38.01
1963	0.692	40.50
1964	0.719	42.43
1965	0.767	45.17
1966	0.806	47.26
1977	0.838	49.26
1968	0.882	51.66
1969	0.929	55.05
1970	1.000	58.34
1971	1.061	62.18
1971	1.109	65.42
1973	1.239	75.98
1974	1.541	92.57
1975	1.724	102.30
1976	1.884	111.80
1977	2.036	119.30
1978	2.114	123.40
1979	2.189	129.30

Sources:

Calendar-year statistics from Japan, Prime Minister's Office, Japan Statistical Yearbook, page 380 in the 1980 edition and the equivalent table in earlier editions; and its Monthly Bulletin of Statistics, April 1981, page 95.

Fiscal-year statistics calculated by converting monthly data from Table 2.8 into a common base of calendar-year 1975 = 100, then averaging over the span of each fiscal year.

Table 2.10--International trade prices (original data)

Calendar year	Rice	Wheat	Corn	Sorghum
	Dollars/ metric ton	--- Dollars/	bushel ---	Cents/ 100 pounds
1960	124.70	1.58	1.26	--
1961	136.51	1.60	1.21	201.00
1962	152.78	1.75	1.24	202.90
1963	143.35	1.76	1.37	217.00
1964	137.73	1.84	1.39	218.60
1965	136.34	1.62	1.41	217.17
1966	163.24	1.72	1.47	220.33
1967	205.98	1.79	1.38	235.42
1968	201.64	1.71	1.21	217.25
1969	186.88	1.59	1.32	223.08
1970	144.00	1.50	1.48	235.08
1971	128.96	1.68	1.48	252.25
1972	147.12	1.90	1.42	253.58
1973	330.42	3.81	2.48	423.42
1974	542.02	4.90	3.36	550.50
1975	363.06	4.06	3.03	526.58
1976	254.59	3.62	2.85	486.83
1977	272.20	2.81	2.42	411.33
1978	367.51	3.48	2.56	443.25
1979	334.19	4.36	2.94	505.75

Sources:

Rice, wheat, and corn: International Monetary Fund, International Financial Statistics Yearbook, 1980, pages 74-77.

Sorghum: U.S. Dept. of Agriculture, Economic Research Service, ECP dataset, logical group ECPM, variable SORGHUM07. This series, divided by 1.7856 to convert it into dollars per bushel, also appears in the USDA publication Agricultural Outlook.

Table 2.11--International trade prices (dollars per metric ton) and the yen-per-dollar exchange rate

Calendar year	Rice price	Wheat price	Corn price	Sorghum price	Exchange rate
	------- Dollars per metric ton			-------	Yen/dollar
1960	124.70	58.06	49.60	--	359.91
1961	136.51	58.79	47.64	44.31	361.15
1962	152.78	64.30	48.82	44.73	360.82
1963	143.35	64.67	53.93	47.84	361.48
1964	137.73	67.61	54.72	48.19	361.97
1965	136.34	59.52	55.51	47.88	361.49
1966	163.24	63.20	57.87	48.57	362.35
1967	205.98	65.77	54.33	51.90	362.15
1968	201.64	62.83	47.64	47.90	360.55
1969	186.88	58.42	51.97	49.18	358.37
1970	144.00	55.12	58.26	51.83	358.15
1971	128.96	61.73	58.26	55.61	348.03
1972	147.12	69.81	55.90	55.91	303.11
1973	330.42	139.99	97.63	93.35	271.22
1974	542.02	180.04	132.28	121.37	291.51
1975	363.06	149.18	119.29	116.09	296.80
1976	254.59	133.01	112.20	107.33	296.55
1977	272.20	103.25	95.27	90.68	268.51
1978	367.51	127.87	100.78	97.72	210.47
1979	334.19	160.20	115.74	111.50	219.17

Note: The prices for wheat, corn, and sorghum shown here, unlike those used in model estimation, are rounded.

Sources:

Rice: From Table 2.10, without modification.

Wheat: From Table 2.10, using a conversion factor of 0.0272155 metric tons per bushel.

Corn: From Table 2.10, using a conversion factor of 0.0254012 metric tons per bushel.

Sorghum: From Table 2.10, using a conversion factor of 2204.634 pounds per metric ton.

Factors converting wheat and corn bushels into metric tons: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, page 624 in the 1979/80 edition.

Exchange rate: International Monetary Fund, International Financial Statistics Yearbook, 1980, pages 248-249, line af.

Table 2.12--International trade prices (current and constant yen per kilogram)

Calendar year	Rice	Wheat	Corn	Sorghum	Rice	Wheat	Corn	Sorghum
	Current yen per kilogram				1970 yen per kilogram			
1960	44.9	20.9	17.9	--	79.3	36.9	31.5	--
1961	49.3	21.2	17.2	16.0	82.7	35.6	28.9	26.9
1962	55.1	23.2	17.6	16.1	86.5	36.4	27.7	25.3
1963	51.8	23.4	19.5	17.3	74.9	33.8	28.2	25.0
1964	49.9	24.5	19.8	17.4	69.3	34.0	27.5	24.3
1965	49.3	21.5	20.1	17.3	64.3	28.1	26.2	22.6
1966	59.2	22.9	21.0	17.6	73.4	28.4	26.0	21.8
1967	74.6	23.8	19.7	18.8	89.0	28.4	23.5	22.4
1968	72.7	22.7	17.2	17.3	82.4	25.7	19.5	19.6
1969	67.0	20.9	18.6	17.6	72.1	22.5	20.0	19.0
1970	51.6	19.7	20.9	18.6	51.6	19.7	20.9	18.6
1971	44.9	21.5	20.3	19.4	42.3	20.2	19.1	18.2
1972	44.6	21.2	16.9	16.9	40.2	19.1	15.3	15.3
1973	89.6	38.0	26.5	25.3	72.3	30.6	21.4	20.4
1974	158.0	52.5	38.6	35.4	102.5	34.1	25.0	23.0
1975	107.8	44.3	35.4	34.5	62.5	25.7	20.5	20.0
1976	75.5	39.4	33.3	31.8	40.1	20.9	17.7	16.9
1977	73.1	27.7	25.6	24.3	35.9	13.6	12.6	12.0
1978	77.3	26.9	21.2	20.6	36.6	12.7	10.0	9.7
1979	73.2	35.1	25.4	24.4	33.5	16.0	11.6	11.2

Note: All data in this table, unlike those used in model estimation, are rounded.

Sources: Prices in dollars per metric ton from Table 2.11 were converted to current yen per kilogram by means of the exchange rate data also in Table 2.11; then the current-yen prices were transformed into constant (1970) yen per kilogram by means of the calendar-year consumer price index series shown in Table 2.9.

For rice, wheat, and barley, the model uses the official resale price (including packing fees) to represent the demand price.

Official resale price statistics are surprisingly difficult to find. The MAF/MAFF statistical yearbook furnishes resale prices only back to 1970. Moreover, for wheat and barley the yearbook fails to specify the month in which each price revision went into effect, and it cites only one price even in years when the price changed twice. Without further information one cannot calculate fiscal-year-average prices.

Rice resale price settings during the 1960's were taken from worksheets compiled by William T. Coyle on the basis of reports prepared by the U.S. Agricultural Attaché's Office in Tokyo. 8/ Rice prices during the 1970's were calculated from data appearing in the "Agricultural Price Support" tables of the MAF/MAFF Statistical Yearbook. John M. Beshoar, of the U.S. Agricultural Counselor's Office in Tokyo, furnished a list of resale prices for wheat, in which the figures for the 1970's correspond to the figures in the agricultural price support tables. A resale price series for barley was patched together by this author from reports prepared by the U.S. Agricultural Attaché's Office in Tokyo (for 1960's data) and from the MAF/MAFF agricultural price support tables (for 1970's data). 9/ To construct this series, it was assumed that the prices of wheat and barley changed on the same dates, and data from the 1960's were adjusted so that they coincide, after rounding, with the barley "Selling Price" recorded in Japanese Agricultural Policies by Roberts, Bain, and Saxon. 10/ Table 2.13 lists the (supposed) resale prices for rice, wheat, and barley, and the (supposed) date each price when into effect. Table 2.14 shows the fiscal-year-average prices calculated from the statistics in Table 2.13, in both current and constant yen. Although the demand price series used here may contain errors, especially as regards barley, it is virtually certain that improving them would not change the conclusions drawn from the model.

The Japanese government places almost no restrictions on the importation of corn and "other grain" (as defined here). So for those two categories, the model uses trade prices in place of demand prices.

Supply Prices. As mentioned above, the Japanese Food Agency sets government purchase prices for rice, wheat, and barley. (Farmers also sell on the private market, where grains above standard quality fetch a premium price.) The official purchase prices, which apply to an entire year's crops, are listed in the Statistical Yearbook, and are reproduced in Table 2.15 below. As with the demand price, the supply price of barley refers to two-row and six-row barley. The price of naked barley is different, but moves in parallel.

Because Japanese production of corn and of other grain is very small and becoming smaller (Tables 2.4 and 2.5), the supply of these crops was just modeled as a time trend. Supply prices were not needed, and therefore not calculated.

Diversion Payments. Roberts, Bain, and Saxon aptly comment that "the typical Japanese solution to the over-production of a particular commodity is not to reduce the support to that commodity but to provide an additional subsidy for producers to do something else" (page 130). In the case of rice, production has exceeded demand since 1966. Starting in 1969, the government has paid

farmers to grow something else. The size of the so-called diversion payment eventually varied with the nature of the crop which replaced rice. Since more land has been diverted to forage crops than to wheat or to barley, in this model the rice diversion payment is set at the subsidy applicable to land diverted from rice to forage crops. The wheat diversion payment and the barley diversion payment are set at the subsidy applicable to land diverted from rice to those crops. Statistics on diversion payments, obtained from Japan's Rice Policy, are shown in Table 2.16. Note that the size of the diversion payment does not depend on the yield of the crop planted in place of rice.

Population

Statistics on the Japanese population as of October 1 (the midpoint of the fiscal year), taken from the Japan Statistical Yearbook, are reproduced in Table 2.17.

The same source conveniently provides estimates of the future population of Japan out to the year 2050, used in Chapter Eight for making projections.

Income

All income variables in the model are derived from fiscal-year GNP statistics. For JFY 1965-79, GNP statistics are based on the United Nations' New System of National Accounts. For JFY 1960-64, they are based on a Japanese system of accounts. In 1965, the earliest year in which GNP figures based on both accounting methods are available, the difference between systems was only 0.5 percent.

Data for JFY 1960-78 come from the Japan Statistical Yearbook; the datum for JFY 1979 comes from the Monthly Statistics of Japan (January 1981). 11/ Table 2.18 shows the GNP figures, both in their original form and transformed into real per-capita terms.

Other Variables

The foregoing variables underlie the regression equations of the Japanese Grains Model. For completeness, the remaining variables and conversion factors included in the model's database will be briefly described.

Information on grain inputs to formula feed is used in Chapter Four as background material. Statistics obtained from Japanese formula feed tables are presented in Tables 4.4 and 4.9, and are documented in the associated text. Chapter Four also contains, in Table 4.3, a set of conversion factors used to transform tons of various grains into tons of corn-equivalent feed.

Chapter Eight presents the values during the 1980-92 projections period known or assumed for the model's exogenous variables: Japanese GNP and population, and world trade prices for rice, wheat, corn, and sorghum.

--Text continues to page 31.

Table 2.13--Resale prices for rice, wheat, and barley (as reported)

Part A: Rice resale prices

Date when price went into effect	Data source	Reported cost: Price / Weight
	Note	Yen / Kg.
April 1, 1960	a	72,517 / 1,000
April 1, 1961	a	72,100 / 1,000
April 1, 1962	a	75,167 / 1,000
April 1, 1963	a	80,317 / 1,000
April 1, 1964	a	83,250 / 1,000
April 1, 1965	a	95,850 / 1,000
April 1, 1966	a	101,783 / 1,000
April 1, 1967	a	109,150 / 1,000
April 1, 1968	a	121,183 / 1,000
April 1, 1969	a	124,950 / 1,000
April 1, 1970	b	7,442 / 60
April 1, 1971	b	7,377 / 60
April 1, 1972	b	7,317 / 60
October 1, 1972	b	7,846 / 60
April 1, 1973	b	7,806 / 60
April 1, 1974	b	7,770 / 60
October 1, 1974	b	10,256 / 60
September 1, 1975	b	12,205 / 60
September 1, 1976	b	13,451 / 60
September 1, 1977	b	14,771 / 60
February 1, 1979	b	15,391 / 60
February 1, 1980	b	15,891 / 60

Sources for rice resale prices:

a: Worksheets compiled by William T. Coyle from data in "Japan: Grain and Feed Report," Foreign Agricultural Service, U.S. Dept. of Agriculture, various issues.

b: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, 1979/80 edition, pages 618-619, and the equivalent table in earlier issues.

(Continues to next page)

Part B: Wheat resale prices

Date when price went into effect	Cost per bag: Price / Weight
	Yen / Kg.
April 1, 1960	2,024 / 60
April 1, 1961	1,996 / 60
April 1, 1962	1,971 / 60
April 1, 1966	1,954 / 60
April 1, 1967	1,941 / 60
April 1, 1969	1,935 / 60
April 1, 1970	1,940 / 60
April 1, 1971	1,944 / 60
April 1, 1972	1,895 / 60
December 1, 1973	2,620 / 60
April 1, 1974	2,589 / 60
April 1, 1975	2,586 / 60
January 1, 1976	2,979 / 60
July 1, 1976	3,297 / 60
April 1, 1978	3,273 / 60
February 1, 1980	3,647 / 60

Source for wheat resale prices:

John M. Beshoar, Agricultural Officer, American Embassy, Tokyo; in personal communication to William T. Coyle, International Economics Division, U.S. Department of Agriculture; November 19, 1981. These figures are consistent with the ones reported in source (b) for rice, bearing in mind that recent editions of the Statistical Yearbook do not include the packing fee of 25 yen per bag, and that the price given for 1975 is either the one which went into effect on April 1, 1975 or the one which went into effect on January 1, 1976, depending on the edition of the yearbook.

Table 2.13--Resale prices for rice, wheat, and barley (as reported)--continued

Part C: Barley resale prices

Date when price went into effect	Data source	Reported cost: Price / Weight	Adjustment per bag: Amount / Weight	Adjusted cost per bag: Price / Weight
	Note	Yen / Kg.	Yen / Kg.	Yen / Kg.
April 1, 1964	a	28,705 / 1,000	- 25 / 52.5	1,482 / 52.5
April 1, 1967	a	28,533 / 1,000	- 25 / 52.5	1,473 / 52.5
April 1, 1968	a	28,571 / 1,000	- 25 / 52.5	1,475 / 52.5
April 1, 1969	a	27,409 / 1,000	- 25 / 52.5	1,414 / 52.5
April 1, 1970	a b	27,467 / 1,000 1,417 / 52.5	- 25 / 52.5 0	1,417 / 52.5
April 1, 1971	b	1,421 / 52.5	0	1,421 / 52.5
April 1, 1972	b,c	1,391 / 52.5	0	1,391 / 52.5
December 1, 1973	b,c d	1,808 / 52.5 1,698 / 50	0 + 25 / 52.5	1,808 / 52.5
April 1, 1974	b,c d	1,781 / 52.5 1,672 / 50	0 + 25 / 52.5	1,781 / 52.5
April 1, 1975	b e	1,778 / 52.5 1,670 / 50	0 + 25 / 52.5	1,778 / 52.5
January 1, 1976	c d	2,110 / 52.5 1,986 / 50	0 + 25 / 52.5	2,110 / 52.5
July 1, 1976	c e	2,437 / 52.5 2,297 / 50	0 + 25 / 52.5	2,437 / 52.5
April 1, 1978	d,e	2,278 / 50	+ 25 / 50	2,303 / 50
February 1, 1980	e	2,540 / 50	+ 25 / 50	2,565 / 50

Sources for barley resale prices:

a: U.S. Dept. of Agriculture, Foreign Agricultural Service, "Japan: Grain and Feed Report," various issues.

b: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, 1974/75 edition, pages 604-605.

c: Ibid, 1976/77 edition, pages 598-599.

d: Ibid, 1977/78 edition, pages 598-599.

e: Ibid, 1979/80 edition, pages 618-619.

Prices apply to two-row and six-row barley, but not naked barley. The dates shown represent the author's assumption that changes in the base price of barley coincided with changes in the base price of wheat. (The Statistical Yearbook specifies only the year, and apparently vacillates between calendar and fiscal years.) The adjustment adds a 25 yen per bag packing fee to the prices given in sources (d) and (e), and subtracts 25 yen per bag from the prices given in source (a), in order to make the time series consistent. See pages 22 and 35 for a more detailed discussion.

Table 2.14--Resale prices for rice, wheat, and barley (fiscal-year averages)

Fiscal year	Rice	Wheat	Barley	Rice	Wheat	Barley
	--- Current yen per kilogram ---			---- 1970 yen per kilogram ----		
1960	72.517	33.73	--	126.175	58.69	--
1961	72.100	33.27	--	118.089	54.49	--
1962	75.167	32.85	--	115.371	50.42	--
1963	80.317	32.85	--	115.696	47.32	--
1964	83.250	32.85	28.23	114.466	45.17	38.82
1965	95.850	32.85	28.23	123.797	42.43	36.46
1966	101.783	32.57	28.23	125.646	40.21	34.85
1967	109.150	32.35	28.06	129.269	38.31	33.23
1968	121.183	32.35	28.10	136.853	36.53	31.73
1969	124.950	32.25	26.93	132.417	34.18	28.54
1970	124.033	32.33	26.99	124.033	32.33	26.99
1971	122.950	32.40	27.07	115.357	30.40	25.40
1972	126.358	31.58	26.50	112.683	28.16	23.63
1973	130.100	35.61	29.14	99.895	27.34	22.37
1974	150.217	43.15	33.92	94.671	27.19	21.38
1975	189.882	44.74	35.45	108.287	25.51	20.22
1976	215.531	53.63	44.86	112.469	27.99	23.41
1977	237.017	54.95	46.41	115.906	26.87	22.70
1978	247.906	54.55	46.06	117.203	25.79	21.78
1979	257.906	55.59	46.93	116.367	25.08	21.17

Sources: Prices were taken from the rightmost columns of Parts A, B, and C of Table 2.13, converted into the price per kilogram, and averaged over April-March fiscal years with each month weighted equally. Then the fiscal-year consumer price index (CPI) series reported in Table 2.9 was used to convert current-yen prices into 1970-yen prices, according to the formula:

(Price in 1970 yen) = (Price in current yen) / (CPI/58.34)

since that CPI series had a value of 58.34 in the year 1970.

Table 2.15--Supply prices for rice, wheat, and barley

Fiscal year	Rice	Wheat	Barley	Rice	Wheat	Barley
	--- Current yen per kilogram ---			---- 1970 yen per kilogram ----		
1960	65.03	35.82	31.73	113.15	62.32	55.21
1961	68.82	38.05	33.35	112.72	62.32	54.62
1962	76.03	40.07	35.12	116.70	61.50	53.90
1963	83.83	41.22	36.11	120.76	59.38	52.02
1964	96.20	43.18	37.85	132.27	59.37	52.04
1965	103.80	45.22	39.64	134.06	58.40	51.20
1966	115.60	48.37	42.40	142.70	59.71	52.34
1967	126.50	50.57	44.30	149.82	59.89	52.47
1968	134.80	52.83	46.30	152.23	59.66	52.29
1969	134.80	54.45	47.73	142.86	57.70	50.58
1970	135.90	57.18	50.13	135.90	57.18	50.13
1971	141.40	61.12	53.56	132.67	57.35	50.25
1972	148.00	63.50	55.66	131.98	56.63	49.64
1973	170.30	72.42	63.47	130.76	55.61	48.73
1974	224.90	92.73	81.28	141.74	58.44	51.22
1975	257.30	102.15	89.54	146.73	58.25	51.06
1976	273.90	109.60	96.04	142.93	57.19	50.12
1977	284.80	158.30	143.80	139.27	77.41	70.32
1978	286.30	161.50	146.70	135.35	76.35	69.36
1979	286.30	165.40	150.30	129.18	74.63	67.82

Note:

In addition to the prices shown above, wheat and barley producers received a bonus of 2,000 yen per bag in 1974 and 1975, and 2,300 yen per bag in 1976. See note 11 on pages 269-270 for details.

Sources:

Supply prices in current yen: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, page 522 in the 1979/80 edition and the equivalent table in earlier editions, with prices converted from yen per bag into yen per kilogram. These figures exclude packing charges, which is why the supply prices of rice reported on page 522 differ from those reported on pages 618-619.

Supply prices in 1970 yen: The current-yen prices were adjusted by the fiscal-year consumer price index series from Table 2.9 (using the same formula as in Table 2.14).

Table 2.16--Diversion payments for rice, wheat, and barley

Fiscal year	Rice a/	Wheat and barley b/	Rice a/	Wheat and barley b/
	Thousands of current yen per hectare		Thousands of 1970 yen per hectare	
To 1968	0	0	0	0
1969	200	200	212	212
1970	350	350	350	350
1971	400	350	375	328
1972	400	350	357	312
1973	400	350	307	269
1974	400	350	252	221
1975	400	350	228	200
1976	400	350	209	183
1977	400	350	196	171
1978	550	550	260	260
1979	550	550	248	248

Notes:

The 1970-yen figures shown here, unlike those used in model estimation, are rounded.

a/ Payment for land diverted from rice to fodder crops.

b/ Payment for land diverted from rice to wheat or barley.

Sources:

Diversion payments in current yen: William T. Coyle, Japan's Rice Policy (Foreign Agricultural Economic Report No. 164, Economic Research Service, U.S. Dept. of Agriculture, July 1981), pages 5-9.

Diversion payments in 1970 yen: Diversion payments in current yen were adjusted by the fiscal-year consumer price index series from Table 2.9 (using the same formula as in Table 2.14).

Table 2.17--Population

Year	Population on October 1
	Thousands
1960	93,419
1961	94,287
1962	95,181
1963	96,156
1964	97,182
1965	98,275
1966	99,036
1967	100,196
1968	101,331
1969	102,536
1970	103,720
1971	105,145
1972	107,595
1973	109,104
1974	110,573
1975	111,940
1976	113,089
1977	114,154
1978	115,174
1979	116,133

Source: Japan, Prime Minister's Office, Japan Statistical Yearbook, 1980 edition, pages 12-13.

Table 2.18--Gross national product

Fiscal year	Gross national product	
	Billions of current yen	Thousands of 1970 yen per capita
1960	16,207	301.856
1961	19,853	344.863
1962	21,660	349.282
1963	25,592	383.389
1964	29,662	419.670
1965	32,982	433.461
1966	38,873	484.538
1967	45,897	542.508
1968	54,577	608.246
1969	64,514	666.786
1970	75,524	728.153
1971	83,166	742.118
1972	96,884	803.001
1973	117,258	825.218
1974	139,219	793.498
1975	153,126	780.107
1976	171,815	792.803
1977	190,713	816.987
1978	209,248	858.931
1979	224,866	873.647

Sources:

GNP in billions of current yen: Japan, Prime Minister's Office, Japan Statistical Yearbook, page 497 in the 1980 edition and the equivalent table in earlier editions; and its Monthly Statistics of Japan, January 1981, page 127. (The most recent Prime Minister's Office publications print a series different from that shown here.)

GNP in thousands of 1970 yen per capita: The current-yen statistics in this table were divided by population figures from Table 2.17, then deflated using the fiscal-year consumer price index series from Table 2.9, according to the formula in Table 2.14.

Finally, the computer database contains some variables which are not used to estimate the model's equations, but are available for statistical experimentation. These are data on the gross domestic product and on private consumption expenditure, 12/ the area planted and the production of feed and forage crops, 13/ the domestic price and the trade price of urea fertilizer, 14/ and the trade price of barley. 15/

GRAPHS OF EXPLANATORY VARIABLES

The model's explanatory variables--prices, the rice diversion payment, population, and real income per capita--are graphed in Figures 2.1 to 2.5. The explained variables--the quantities in food balance sheets, yields, and areas--are graphed in subsequent chapters.

Figure 2.1
Rice Prices

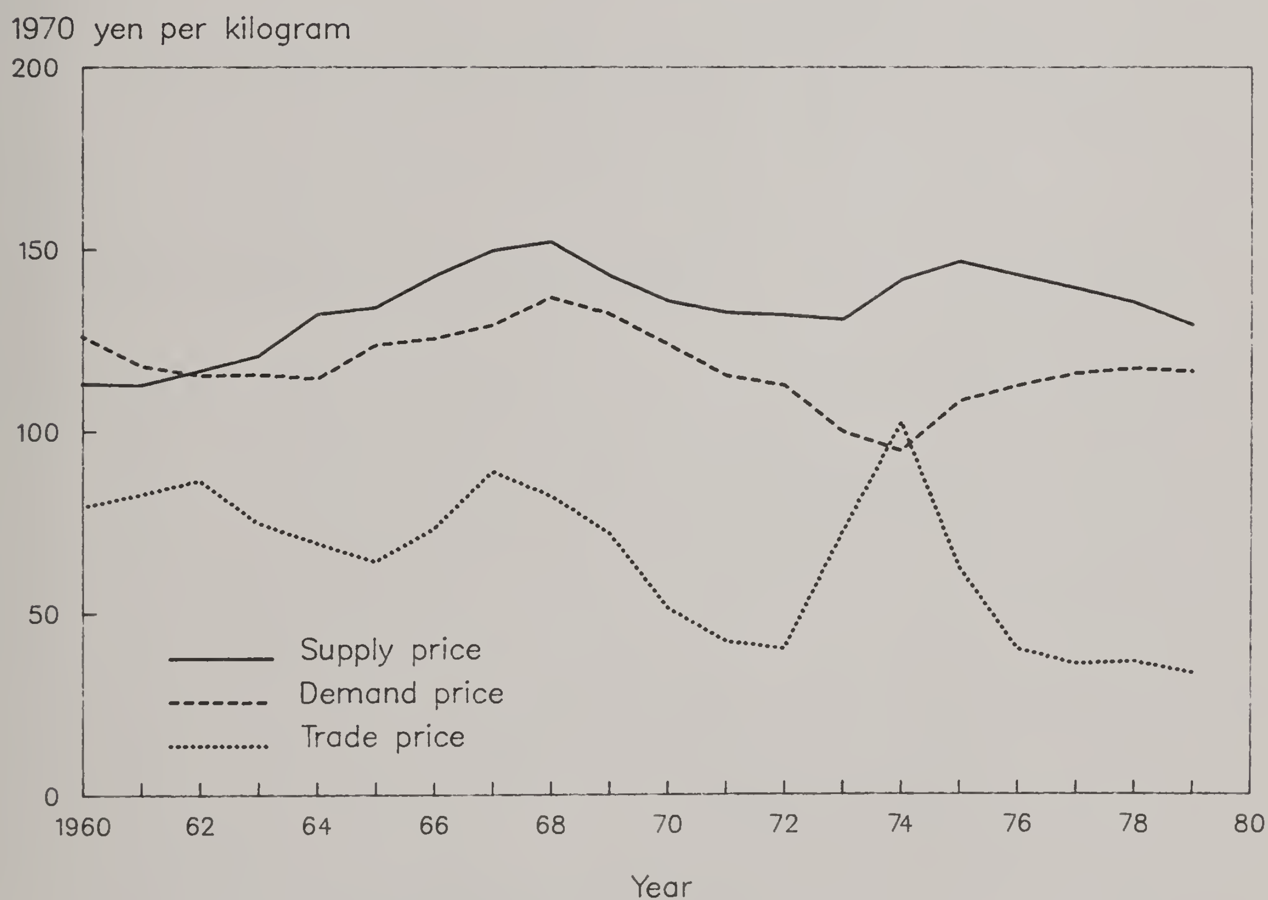


Figure 2.2
Wheat Prices

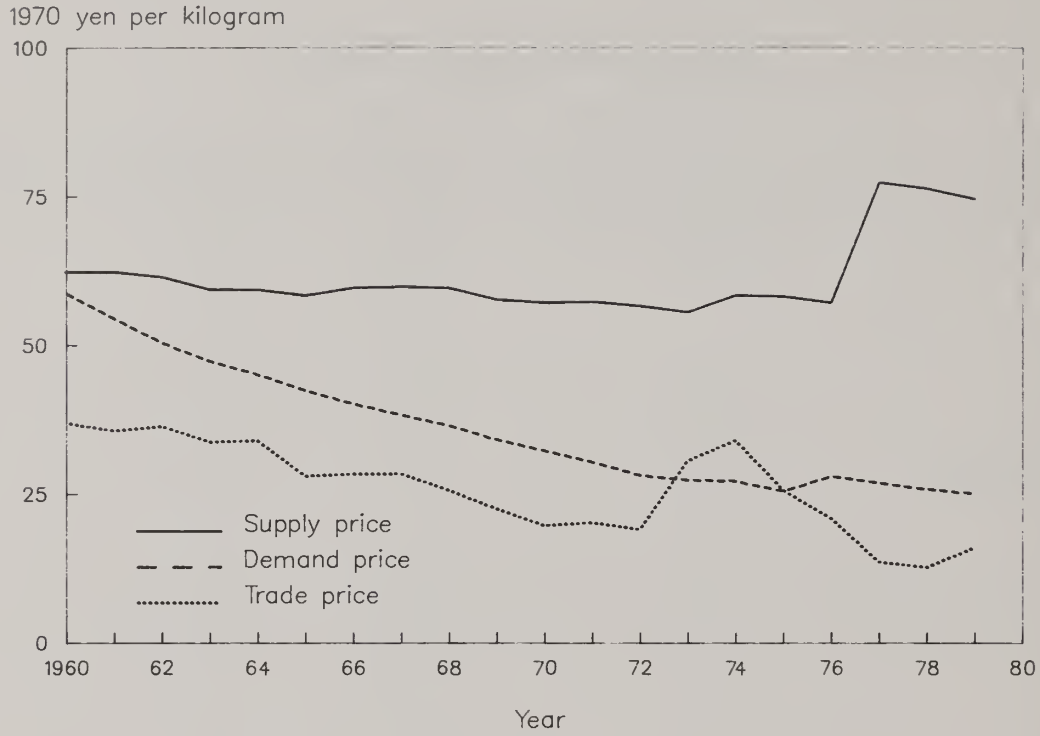


Figure 2.3
Coarse Grain Prices

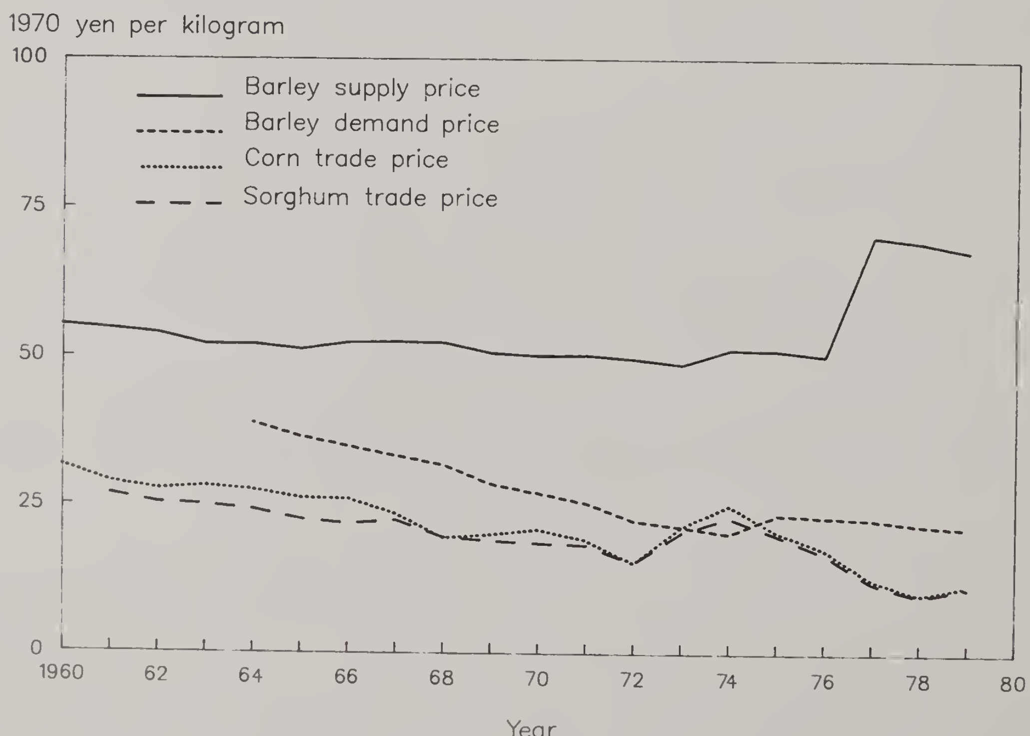


Figure 2.4
Rice Diversion Payments

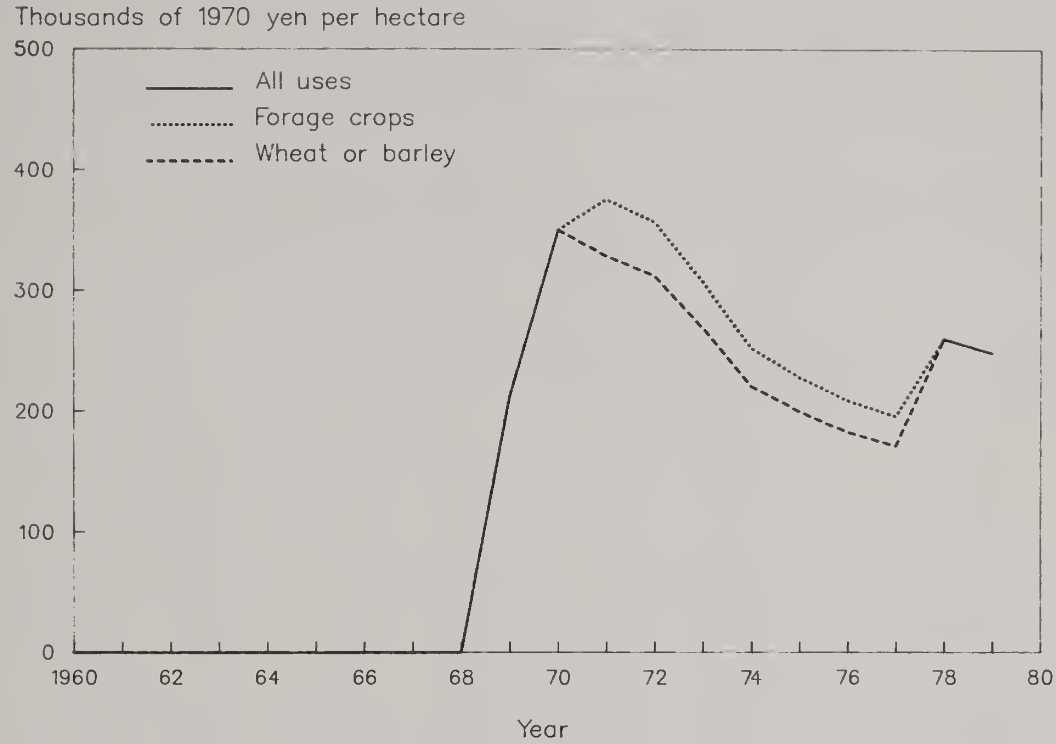
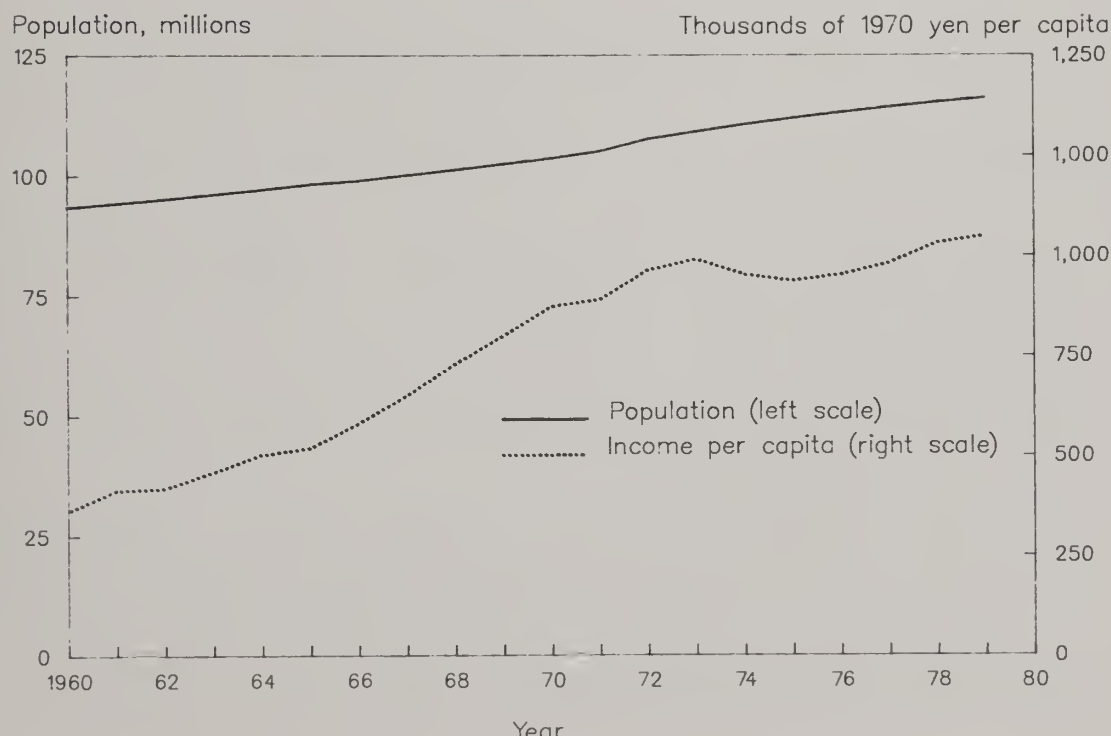


Figure 2.5
Population and Income Per Capita



1/ The exception to this rule is that in the Japanese food balance sheets, rice imports are recorded on a milled basis. Within the period 1960-79, imports were highest in 1965. Adjusting imports to a brown basis in 1965 would have increased the sum of food use, feed use, and additions to stocks by 0.8 percent; in 1979, adjusting imports to a brown basis would have increased this sum by 0.02 percent. The import figures were not augmented to a brown basis for this model, both because the effect would have been so small, and because there would have been no grounds on which to allocate the resultant nominal increase in tonnage between food use, feed use, and additions to stocks.

2/ The milling rate appears in the food balance sheets as the "Extraction Rate" used to convert "Gross Food" into "Net Food". These extraction rates are specified as follows:

Fiscal Year	1960	1961	1962	1963	1964
Total Rice	.911	.911	.907	.907	.909
Domestic Rice	.91	.91	.906	.906	.906

Fiscal Year	1965	1966	1967	1968	1969
Total Rice	.912	.910	.908	.907	.907
Domestic Rice	.906	.906	.906	.906	.906

Fiscal Year	1970	1971	1972	1973	1974
Total Rice	.905	.905	.905	.905	.906
Domestic Rice	.905	.905	.905	.905	.906

Fiscal Year	1975	1976	1977	1978	1979
Total Rice	.906	.906	.908	.906	.906
Domestic Rice	.906	.906	.907	.906	.906

3/ The exceptions are the sizes of diversion payments and the dates on which changes in the resale prices of wheat and barley went into effect. Information on these can be obtained from reports prepared for the USDA's Foreign Agricultural Service by the Office of the Agricultural Counselor in Tokyo, such as the "Japan: Grain and Feed Report" series.

4/ For example, the "Explanatory Notes" to the Food Balance Sheets: 1955-1966 state on page 27, concerning rice: "'Waste' has been put at 2 percent of what is left after subtracting 'animal feed', 'seed' and 'manufacture' from 'available supply'."

5/ Thus the production levels reported alongside areas in the calendar-year crop tables coincide (after rounding) with the production levels reported in the fiscal-year food balance sheets.

6/ The original statistics are calculated the other way around: each of various area categories (such as upland rice or naked barley) is multiplied by an estimated average yield to obtain reported production.

7/ The commodities are defined on page 433 of the December 1980 issue of International Financial Statistics: rice, white, milled, 5 percent broken, government standard, export price f.o.b., Bangkok, in U.S.

dollars per metric ton; wheat, No. 2 hard red winter ordinary protein, f.o.b. U.S. Gulf ports, in dollars per bushel; maize, yellow No. 2, f.o.b. U.S. Gulf ports, also in dollars per bushel.

8/ Coyle's price series, divided by 0.91 to convert it into a milled-rice basis, appears in Japan's Rice Policy, Table 1 on page 3, and Appendix Table 1 on page 26. Like Japanese government publications, this model measures Japanese demand and supply prices on a brown-rice basis. (World trade prices, however, are measured on milled-rice basis.)

9/ The time series data on barley resale prices seem to change between issues of the Statistical Yearbook. The reasons for the apparent inconsistencies presumably are as follows:

a. The 1974/75 edition of the Statistical Yearbook reports for 1975 the price of 1,778 yen per 52.5-kilogram bag which became effective in April 1975, at the beginning of fiscal year 1975. Later editions of the Statistical Yearbook report for 1975 the price of 2,110 yen per 52.5-kilogram bag which became effective in January 1976 (January 1976 still falls within the fiscal year 1975).

b. Starting with the 1977/78 Statistical Yearbook, prices are quoted per 50-kilogram bag excluding packing charges; previous issues quote prices per 52.5-kilogram bag including a 25 yen per bag packing charge. (Perhaps the standard weight for a bag of barley was lowered from 52.5 kilograms to 50 kilograms at the beginning of fiscal year 1978.) In the price figures used for the Japanese Grains Model, a packing fee of 25 yen per 50-kilogram bag is assumed to apply since JFY 1978.

c. In the 1977/78 Statistical Yearbook, the 1975 price is given as 1,986 yen per 50-kilogram bag. This figure apparently was calculated as (2,110 - 25) x (50/52.5). In subsequent editions of the Statistical Yearbook, the 1975 price is given as 1,670 yen per 50-kilogram bag, apparently derived as (1,778 - 25) x (50/52.5). See (a) for the relationship between 1,778 and 2,110.

10/ Table 4 on page 45. The barley price statistics used here (as listed in Table 2.13) coincide, after rounding, with the figures shown in Japanese Agricultural Policies for all but four of the fiscal years from 1965 to 1979. The exceptions are 1973, 1975, 1976, and 1979. In each of these cases the official barley resale price changed during the course of the fiscal year, whereas the statistic shown in Japanese Agricultural Policies is calculated as if a single price had prevailed throughout the fiscal year. For JFY 1979, the price reported in Japanese Agricultural Policies does not include a packing charge. Data from the USDA Foreign Agricultural Service over the span JFY 1965-70 are compatible with the price series reported in Japanese Agricultural Policies (and for JFY 1970, compatible with the price reported in the MAF Statistical Yearbook) only if 25 yen per 52.5 kilograms is subtracted from them. The price series used in the Japanese Grains Model incorporates this adjustment. (The reason for the discrepancy is unclear--perhaps the Foreign Agricultural Service statistics refer to a different category of barley, or perhaps there is some confusion over the packing charge.)

11/ Starting with the February 1981 issue of the Monthly Statistics of Japan and starting with the 1981 edition of the Japan Statistical Yearbook, the Prime Minister's Office has been publishing a revised set of national accounts statistics. The new series implies a slightly lower growth rate than the series published through January 1981, so regression equations estimated with data from the new series would indicate slightly higher income elasticities. The new series does not include any statistics for the fiscal years 1966 and 1967. The 1981 Japan Statistical Yearbook offers no explanation for the revisions--the new series, like the one it replaces, is said to be based on the United Nations' new system of national accounts.

12/ The same statistical sources are used to obtain data on gross national product (GNP), gross domestic product (GDP), and private consumption expenditure. These national account figures are recorded in the model's database both for fiscal years and for calendar years (but the calendar-year figures recorded for the 1960's are merely interpolations of fiscal-year data). The January 1981 Monthly Statistics of Japan does not furnish a 1980 GDP figure. However, the difference between GNP and GDP is the same in the "old" and "new" national account series. Thus the difference between the "new" 1980 GNP and the "new" 1980 GDP, as shown in the February 1981 Monthly Statistics of Japan, was subtracted from the "old" 1980 GNP published in the January Monthly Statistics of Japan, to derive a 1980 GDP figure consistent with the "old" series.

13/ MAFF Abstract of Statistics, 1979 edition, page 51, and the equivalent table in earlier editions.

14/ The domestic price of fertilizer in yen per kilogram is derived from the price per 20-kilogram bag of urea (46 percent nitrogen) published on page 229 of the 1979/80 edition of the MAFF Statistical Yearbook, and the equivalent table in earlier issues. The trade price for urea, bagged (f.o.b. Europe), in dollars per metric ton, is obtained from the 1980 International Financial Statistics Yearbook, pages 76-77.

15/ The barley trade price is taken from the USDA Economic Research Service's ECP dataset, logical group ECPM, variable BARLEY19, there defined as the wholesale and export price for Canadian domestic No. 1 feed barley, in Canadian dollars per metric ton. Essentially the same price series can be found in the Grain and Oilseeds Review published by Statistics Canada (page 24 in the April 1981 issue, for example), though the monthly data printed there would have to be aggregated into calendar-year averages. For the model's database, Canadian dollars were converted into U.S. dollars using the exchange rates shown on line af, pages 130-131 of the 1980 International Financial Statistics Yearbook; then U.S. dollars were converted into yen as described above in the section on trade prices.

CHAPTER THREE

FOOD

SUMMARY

The food demand component of the Japanese Grains Model contains six behavioral equations and eight definitional identities.

For each of six grain categories, a behavioral equation calculates the logarithm of food consumption per capita--either as a function of per capita income measured in constant yen, or as a simple time trend, or in one case as a constant value. In the behavioral equation for corn, the trend growth rate of per capita consumption observed over 1972-79 is assumed to decline by a half percentage-point per year, starting in 1980, until corn food consumption per person stabilizes in 1994.

Six identities convert annual food grain demand from the logarithm of kilograms per person into the national total in thousand metric tons. The remaining identities add barley used directly plus barley used industrially to obtain total barley, and add barley plus other grain to obtain the GOL Model category other coarse grains.

<u>Behavioral Equations:</u>

```
[1]  JPLQDRIF = 44.775866 - 0.020318270 * YEAR

[2]  JPLQDWHF = 3.792007

[3]  JPLQDBDF = 65.258402 - 8.841757 * JPLGNPFY - 4216.885 * JP1GNPFY

[4]  JPLQDBIF = - 108.629 + 0.055934240 * YEAR

[5]  IF YEAR LE 1979 THEN
       JPLQDCNF = - 149.472 + 0.077000073 * YEAR

     ELSE IF YEAR LE 1994 THEN
       JPLQDCNF = LAG1(JPLQDCNF) + 0.077000073 - 0.005 * (YEAR - 1979)

     ELSE
       JPLQDCNF = LAG1(JPLQDCNF)

[6]  JPLQDOGF = - 71.800532 + 0.036301028 * YEAR
```

<u>Identities:</u>

```
[7]  JPQDRIFY = ROUND( JPPOPFY * EXP(JPLQDRIF) / 1000 )

[8]  JPQDWHFY = ROUND( JPPOPFY * EXP(JPLQDWHF) / 1000 )

[9]  JPQDBDFY = ROUND( JPPOPFY * EXP(JPLQDBDF) / 1000 )

[10] JPQDBIFY = ROUND( JPPOPFY * EXP(JPLQDBIF) / 1000 )
```

[11] JPQDCNFY = ROUND(JPPOPFY * EXP(JPLQDCNF) / 1000)

[12] JPQDOGFY = ROUND(JPPOPFY * EXP(JPLQDOGF) / 1000)

[13] JPQDBAFY = JPQDBDFY + JPQDBIFY

[14] JPQDCGFY = JPQDBAFY + JPQDOGFY

where:

* indicates multiplication

LE signifies "less than or equal to"

LAG1(x) is the value of "x" lagged by 1 year

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

and where:

JPQDaaFY = Japan, quantity of aa used as food, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley
BD = barley used directly
BI = barley used industrially
CN = corn
OG = other grain
CG = other coarse grains

JPLQDaaF = Japan, logarithm of quantity of aa used as food, fiscal year (kilograms per capita); with aa defined as above.

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)

JPPOPFY = Japan, population on October 1 (thousands)

YEAR = Japanese fiscal year (for example, 1979)

REVIEW OF DATA

Data on the food use of grains are summarized in the two tables below. Table 3.1 displays statistics collected from the food balance sheets presented in Chapter Two; Table 3.2 converts those statistics into kilograms consumed per capita, using population data also presented in Chapter Two.

Table 3.1--Quantities of grain used as food

Fiscal year	Rice	Wheat	Barley	Corn	Other grain
	Thousand metric tons				
1960	12,494	3,457	1,559	--	--
1961	12,941	3,531	1,212	--	--
1962	13,197	3,588	1,105	--	--
1963	13,277	3,739	965	--	--
1964	13,240	3,944	1,047	--	--
1965	12,872	4,075	1,003	--	--
1966	12,372	4,418	995	--	--
1967	12,354	4,490	980	--	--
1968	12,121	4,503	956	--	--
1969	11,834	4,561	910	--	--
1970	11,827	4,495	813	--	--
1971	11,750	4,565	840	--	--
1972	11,742	4,610	847	1,195	93
1973	11,971	4,785	988	1,128	105
1974	11,927	4,890	998	1,412	79
1975	11,858	4,979	1,013	1,364	93
1976	11,709	5,076	1,010	1,736	109
1977	11,377	5,114	1,059	1,855	102
1978	11,264	5,178	1,047	1,995	118
1979	11,121	5,316	1,031	2,084	132

Note: The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Taken from Tables 2.1 through 2.5, which in turn are based on Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions, and its revised Food Balance Sheets: 1955-1966. The corrected 1977 corn statistic was furnished by William L. Davis, Agricultural Counselor, American Embassy, Tokyo, on the basis of conversations with MAFF officials (personal correspondence to William T. Coyle and the author, February 17, 1983).

Table 3.2--Grain food consumption per person

Fiscal year	Rice	Wheat	Barley	Corn	Other grain
	Kilograms per capita				
1960	133.7	37.0	16.7	--	--
1961	137.3	37.4	12.9	--	--
1962	138.7	37.7	11.6	--	--
1963	138.1	38.9	10.0	--	--
1964	136.2	40.6	10.8	--	--
1965	131.0	41.5	10.2	--	--
1966	124.9	44.6	10.0	--	--
1967	123.3	44.8	9.8	--	--
1968	119.6	44.4	9.4	--	--
1969	115.4	44.5	8.9	--	--
1970	114.0	43.3	7.8	--	--
1971	111.8	43.4	8.0	--	--
1972	109.1	42.8	7.9	11.1	0.86
1973	109.7	43.9	9.1	11.3	0.96
1974	107.9	44.2	9.0	12.8	0.71
1975	105.9	44.5	9.0	12.2	0.83
1976	103.5	44.9	8.9	15.4	0.96
1977	99.7	44.8	9.3	16.2	0.89
1978	97.8	45.0	9.1	17.3	1.02
1979	95.8	45.8	8.9	17.9	1.14

Notes: The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

The figures shown here, unlike those used in model estimation, are rounded.

Sources: Calculated from data in Table 3.1 and from population statistics in Table 2.8.

Food demand for grains is assumed to be proportional to population, and to be dependent on real income per capita and on real grain prices. Thus:

$$\frac{\text{Food demand}}{\text{Population}} = f\left(\frac{\text{Gross national product / Population}}{\text{Consumer price index}}, \frac{\text{Own price}}{\text{Consumer price index}}, \frac{\text{Different grain prices}}{\text{Consumer price index}}\right)$$

Substituting variable abbreviations, this relationship can be written as:

$$\frac{QD}{POP} = f\left(\frac{GNP/POP}{CPI}, \frac{[PD]}{CPI}\right)$$

where [PD] represents a set of demand prices for grains. Three specific functional forms were assayed: double-log, log-log-inverse, and a simple exponential time trend. These forms are embodied, respectively, in the following equations:

$$LOG\left(\frac{QD}{POP}\right) = a + b\ LOG\left(\frac{GNP/POP}{CPI}\right) + \sum_i c_i\ LOG(PD_i/CPI)$$

$$LOG\left(\frac{QD}{POP}\right) = a + b_1\ LOG\left(\frac{GNP/POP}{CPI}\right) + b_2\left(\frac{CPI}{GNP/POP}\right) + \sum_i c_i\ LOG(PD_i/CPI)$$

$$LOG\left(\frac{QD}{POP}\right) = a + d\ (YEAR)$$

<u>where</u>:

LOG is the natural logarithm operator

a is an intercept term

b is an income elasticity

b_1 and b_2 are other parameters measuring the income sensitivity of demand, whose signs should be negative 1/

c_i is an element of a vector of own- and cross-price elasticities

d is a constant rate of growth (or decline, when negative)

In regression equations, the prices of competing food grains can be measured either in constant yen or as a ratio to the price of the food grain whose consumption is being estimated.

To summarize results discussed in detail below, the best estimates were produced by quite simple equations. In many cases a time trend better fit the historical data than regressions on income and prices. In no case was a regression equation incorporating a price term selected for use in the model,

either because a time trend gave more accurate predictions, or because when price coefficients were included in the regression equation, they had very low significance levels or the wrong sign. Instead, food demand for grains was modeled solely as a function of income, or even more simply as a function of time. Of course, it is not surprising that in a well-to-do country, food grain consumption is insensitive to grain prices. Japanese households can easily afford to eat all the grains they want, and scarcely modify their consumption when the cost changes. Changes in income can affect grain consumption--for example, by encouraging the substitution of fish and meat for cereals.

The model uses the food demand equations which (in its author's opinion) best predict the most likely course of events. However, those equations often do not permit policy analysis. Therefore alternative equations which do include income and price terms are presented at the end of this chapter.

RICE

No regression equation approximates rice consumption better than a simple time trend--an adjusted R^2 of nearly 98 percent is hard to surpass. In the equation displayed below, the first line shows coefficients; the second, their standard error; the third, the absolute value of the corresponding t-statistic; and the fourth, the significance level attained. 2/

$$
\begin{array}{lll}
\text{JPLQDRIF} = & 44.775866 & - \; 0.020318270 \text{ YEAR} \\
 & \pm \; 1.593522 & \pm \; 0.000808072 \\
 & (28.099) & (25.144) \\
 & 0.01\% & 0.01\%
\end{array}
$$

Adjusted R^2 = 97.83 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 0.927
Autocorrelation of residuals = 0.406

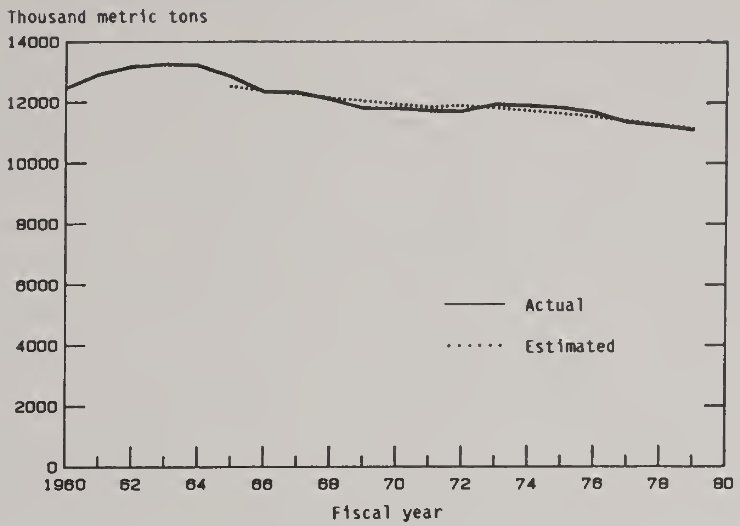
JPLQDRIF = Japan, logarithm of rice used as food, fiscal year (kilograms per capita, brown basis)

YEAR = Japanese fiscal year (values from 1965 to 1979)

The equation states that each year's per capita rice consumption will be 2 percent below the previous year's level. Thus in the year 2000, per capita rice consumption is projected at 62 kilograms per person per year, 65 percent of its level in 1979.

Table 3.3 and Figure 3.1 compare actual and estimated rice consumption. For these comparisons, the levels predicted by the regression equation have been converted from the logarithm of kilograms per capita into the equivalent national total in thousand metric tons. Because the estimate plus the residual sum to the actual value, a positive residual implies that the estimate is too low.

Figure 3.1
Actual and Estimated Rice Food Consumption



Source: Table 3.3

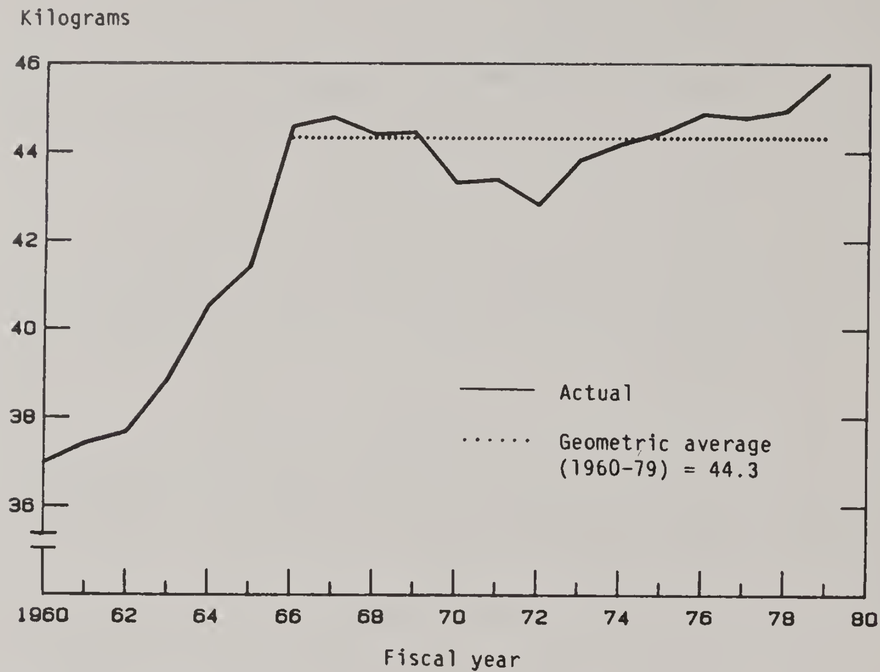
Table 3.3--Actual and estimated rice food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	12,494	--	--	--
1961	12,941	--	--	--
1962	13,197	--	--	--
1963	13,277	--	--	--
1964	13,240	--	--	--
1965	12,872	12,560	312	2.4
1966	12,372	12,402	-30	-0.2
1967	12,354	12,295	59	0.5
1968	12,121	12,184	-63	-0.5
1969	11,834	12,081	-247	-2.1
1970	11,827	11,975	-148	-1.3
1971	11,750	11,895	-145	-1.2
1972	11,742	11,928	-186	-1.6
1973	11,971	11,852	119	1.0
1974	11,927	11,770	157	1.3
1975	11,858	11,675	183	1.5
1976	11,709	11,558	151	1.3
1977	11,377	11,432	-55	-0.5
1978	11,264	11,302	-38	-0.3
1979	11,121	11,167	-46	-0.4
		Mean absolute value:	129	1.1
		Root mean square:	152	1.3

Note: Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 3.1 and model estimates.

Figure 3.2
Japanese Wheat Consumption Per Capita:
Actual and Geometric Average



Source: Table 3.2

WHEAT

From 1960 to 1966, per capita wheat consumption grew at a compound rate of 3 percent per year; but from then on, consumption did not display any trend (Figure 3.2). 3/ The model assumes, therefore, that Japanese wheat consumption has reached a saturation point. More specifically, wheat consumption per capita is estimated to remain constant at its geometric average level over the period 1966-79, in accordance with the equation below: 4/

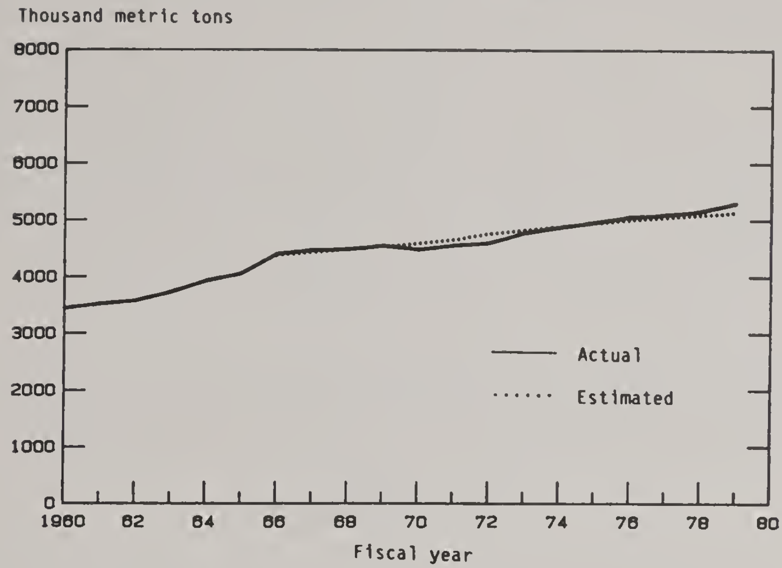
$$\text{JPLQDWHF} = \underset{\substack{(818.8) \\ 0.01\%}}{3.792007 \pm 0.004631}$$

R^2 = 0 percent for 14 observations (JFY 1966-79)
Durbin-Watson statistic = 0.517
Autocorrelation of residuals = 0.608

JPLQDWHF = Japan, logarithm of wheat used as food, fiscal year (kilograms per capita)

Because wheat food use per capita has varied so little over a 14-year span, this extremely simple equation usually gives an accurate estimate, as can be seen from Table 3.4 and Figure 3.3. Of course, constant wheat consumption per capita multiplied by a growing population implies rising total consumption.

Figure 3.3
Actual and Estimated Wheat Food Consumption



Source: Table 3.4

Table 3.4--Actual and estimated wheat food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	3,457	--	--	--
1961	3,531	--	--	--
1962	3,588	--	--	--
1963	3,739	--	--	--
1964	3,944	--	--	--
1965	4,075	--	--	--
1966	4,418	4,392	26	0.6
1967	4,490	4,443	47	1.0
1968	4,503	4,494	9	0.2
1969	4,561	4,547	14	0.3
1970	4,495	4,599	-104	-2.3
1971	4,565	4,663	-98	-2.1
1972	4,610	4,771	-161	-3.5
1973	4,785	4,838	-53	-1.1
1974	4,890	4,903	-13	-0.3
1975	4,979	4,964	15	0.3
1976	5,076	5,015	61	1.2
1977	5,114	5,062	52	1.0
1978	5,178	5,107	71	1.4
1979	5,316	5,150	166	3.1
		Mean absolute value:	64	1.3
		Root mean square:	81	1.7

Sources: Table 3.1 and model estimates.

The Special Nature of Barley Consumption

Barley food consumption in Japan comprises two very different kinds of end use. Some barley is directly consumed, mostly in the form of an inferior grain. The rest is used as an input to manufacturing--especially beer. Direct consumption has steadily fallen while industrial use has steadily expanded (Table 3.5). This explains the pattern of a falling, then rising level of total barley consumption: the total was dominated in the 1960's by a declining direct use, and dominated in the 1970's by a rising industrial use.

While the ratio of industrial use to direct use has changed drastically for barley, it has not changed much for other grains (Table 3.6).

To reflect its dual nature, barley food consumption is disaggregated in the model into barley used directly and barley used industrially.

Direct Barley Use

The most accurate approximation to direct barley consumption is given by a log-log-inverse functional form, which has an adjusted R^2 statistic of almost 94 percent:

$$\begin{array}{lllll} \text{JPLQDBDF} = & 65.258402 & - \ 8.841757 \ \text{JPLGNPFY} & - \ 4216.885 \ \text{JP1GNPFY} \\ & \pm \ 12.138332 & \pm \ 1.629718 & \pm \ 1002.515 \\ & (5.376) & (5.425) & (4.206) \\ & 0.02\% & 0.02\% & 0.12\% \end{array}$$

Adjusted R^2 = 93.71 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 1.208
Autocorrelation of residuals = 0.287

JPLQDBDF = Japan, logarithm of food barley used directly, fiscal year (kilograms per capita)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)

Actual and estimated direct food uses of barley are compared in Table 3.7 and Figure 3.4.

Table 3.5--Division of barley food consumption between direct use and industrial use

Fiscal year	Total	Direct use	Industrial use	Total	Direct use	Industrial use	Direct use	Industrial use
	Thousand metric tons			Kilograms per capita			Percent of total	
1960	1,559	1,349	210	16.7	14.4	2.2	87	13
1961	1,212	955	257	12.9	10.1	2.7	79	21
1962	1,105	815	290	11.6	8.6	3.0	74	26
1963	965	676	289	10.0	7.0	3.0	70	30
1964	1,047	692	355	10.8	7.1	3.7	66	34
1965	1,003	649	354	10.2	6.6	3.6	65	35
1966	995	620	375	10.0	6.3	3.8	62	38
1967	980	600	380	9.8	6.0	3.8	61	39
1968	956	544	412	9.4	5.4	4.1	57	43
1969	910	427	483	8.9	4.2	4.7	47	53
1970	813	306	507	7.8	3.0	4.9	38	62
1971	840	323	517	8.0	3.1	4.9	38	62
1972	847	264	583	7.9	2.5	5.4	31	69
1973	988	319	669	9.1	2.9	6.1	32	68
1974	998	299	699	9.0	2.7	6.3	30	70
1975	1,013	294	719	9.0	2.6	6.4	29	71
1976	1,010	278	732	8.9	2.5	6.5	28	72
1977	1,059	267	792	9.3	2.3	6.9	25	75
1978	1,047	192	855	9.1	1.7	7.4	18	82
1979	1,031	167	864	8.9	1.4	7.4	16	84

Note: The figures on per capita consumption and on percent of total, unlike those used in model estimation, are rounded.

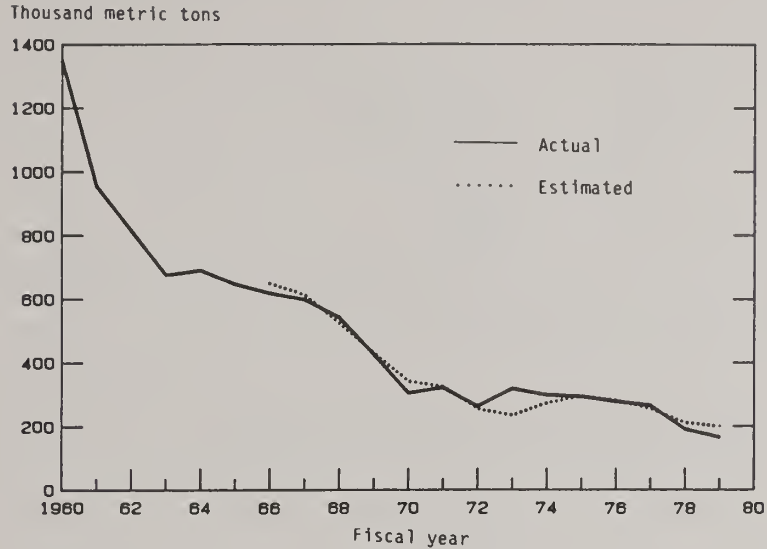
Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966.

Table 3.6--Shares of direct use and industrial use in food grain consumption

Fiscal year	Rice		Wheat		Barley		Corn		Other grain	
	Direct	Industrial	Direct	Industrial	Direct	Industrial	Direct	Industrial	Direct	Industrial
	Percent									
1965	95	5	94	6	65	35	--	--	--	--
1972	94	6	95	5	31	69	9	91	73	27
1979	94	6	92	8	16	84	4	96	73	27

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966.

Figure 3.4
Actual and Estimated Direct Barley Food Consumption



Source: Table 3.7

Table 3.7--Actual and estimated direct barley food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	1,349	--	--	--
1961	955	--	--	--
1962	815	--	--	--
1963	676	--	--	--
1964	692	--	--	--
1965	649	622	27	4.2
1966	620	652	-32	-5.2
1967	600	616	-16	-2.7
1968	544	525	19	3.5
1969	427	433	-6	-1.4
1970	306	343	-37	-12.1
1971	323	328	-5	-1.5
1972	264	257	7	2.7
1973	319	236	83	26.0
1974	299	275	24	8.0
1975	294	296	-2	-0.7
1976	278	283	-5	-1.8
1977	267	256	11	4.1
1978	192	213	-21	-10.9
1979	167	201	-34	-20.4
	Mean absolute value:		22	7.0
	Root mean square:		30	10.1

Sources: Table 3.1 and model estimates.

Industrial Barley Use

The most precise estimates of the industrial usage of barley are produced by a time trend:

$$
\begin{array}{llll}
\text{JPLQDBIF} = & -\ 108.629 & + & 0.055934240\ \text{YEAR} \\
 & \pm\ 5.149 & & \pm\ 0.002610892 \\
 & (21.098) & & (21.423) \\
 & 0.01\% & & 0.01\%
\end{array}
$$

Adjusted R^2 = 97.03 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 1.146
Autocorrelation of residuals = 0.359

JPLQDBIF = Japan, logarithm of food barley used industrially, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1965 to 1979)

The estimates derived from this regression equation are compared with actual data in Table 3.8 and Figure 3.5.

The time trend used in the model implies a growth rate of nearly 6 percent per year, so that industrial use of barley per capita is projected to be 1.9 times as great in 1990 as in 1979, and 3.2 times as great in 2000 as in 1979. This appears to be too high, especially for the year 2000. Thus when the Japanese Grains Model is incorporated in the longer range GOL Model, it might be preferable to substitute the following regression equation, despite its worse performance in tracking historical data:

$$
\begin{array}{llll}
\text{JPLQDBIF} = & -\ 5.367959 & + & 1.074322\ \text{JPLGNPFY} \\
 & \pm\ 0.832166 & & \pm\ 0.126901 \\
 & (6.451) & & (8.466) \\
 & 0.01\% & & 0.01\%
\end{array}
$$

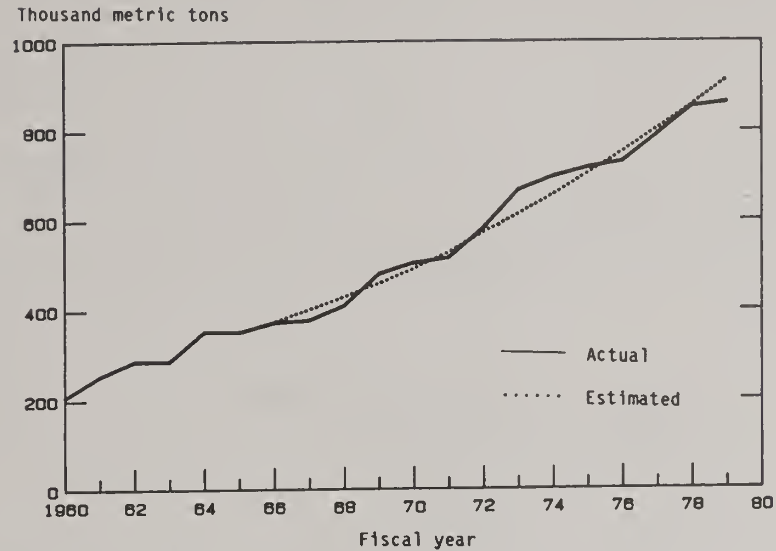
Adjusted R^2 = 83.47 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 0.328
Autocorrelation of residuals = 0.743

JPLQDBIF = Japan, logarithm of food barley used industrially, fiscal year (kilograms per capita)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

When coupled with a reasonable projection of growth in real income per capita (3.9 percent per year), 5/ this specification implies that the industrial use of barley per capita will grow by 4.2 percent per year, which would make it 1.6 times as large in 1990 as in 1979, and 2.4 times as large in 2000 as in 1979.

Figure 3.5
Actual and Estimated Industrial Barley Food Consumption



Source: Table 3.8

Table 3.8--Actual and estimated industrial barley food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	210	--	--	--
1961	257	--	--	--
1962	290	--	--	--
1963	289	--	--	--
1964	355	--	--	--
1965	354	354	0	0.0
1966	375	377	-2	-0.5
1967	380	404	-24	-6.3
1968	412	432	-20	-4.9
1969	483	462	21	4.3
1970	507	494	13	2.6
1971	517	530	-13	-2.5
1972	583	574	9	1.5
1973	669	615	54	8.1
1974	699	659	40	5.7
1975	719	706	13	1.8
1976	732	754	-22	-3.0
1977	792	805	-13	-1.6
1978	855	859	-4	-0.5
1979	864	916	-52	-6.0
		Mean absolute value:	20	3.3
		Root mean square:	26	4.1

Sources: Table 3.1 and model estimates.

Total Barley Food Use

The estimated total food use of barley is calculated as the estimated direct use plus the estimated industrial use. These estimates are compared to actual total consumption in Table 3.9 and Figure 3.6.

CORN

Nearly all "food" corn is used as an industrial raw material, mostly to produce starch and sweeteners.

By far the most accurate estimates of corn food consumption are produced by a simple time trend:

$$\begin{array}{llll} \text{JPLQDCNF} = & -\ 149.472 & + & 0.077000073\ \text{YEAR} \\ & \pm\ 16.478 & \pm & 0.008341017 \\ & (9.071) & & (9.231) \\ & 0.01\% & & 0.01\% \end{array}$$

Adjusted R^2 = 92.33 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 2.937
Autocorrelation of residuals = -0.448

JPLQDCNF = Japan, logarithm of corn used as food, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1972 to 1979)

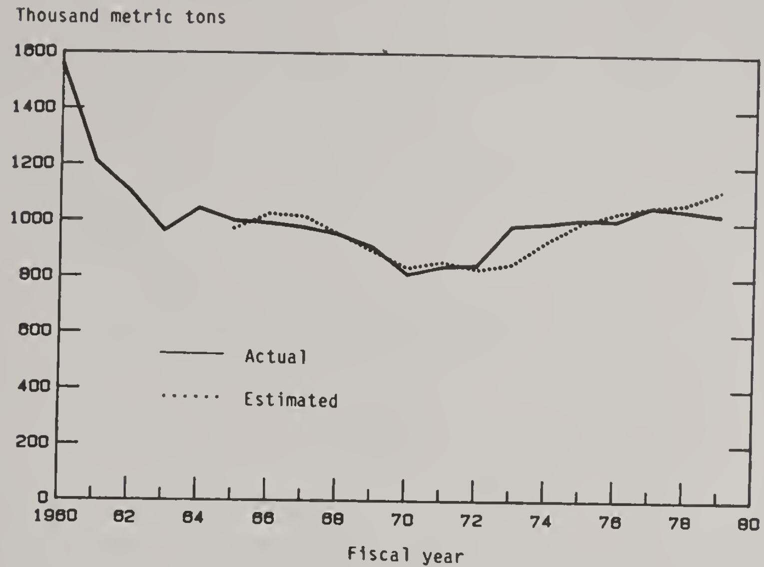
Table 3.10 and Figure 3.7 compare actual and estimated corn consumption.

It is clear that corn food consumption per capita cannot grow forever by 8 percent per year (at that rate, consumption per person would be 2.2 times as high in 1990 as in 1979, and 5.0 times as high in 2000 as in 1979). However, the 8 years of available data provide no way of determining how soon or how quickly the growth rate will fall. In the absence of econometric evidence, this model arbitrarily assumes that the growth rate of corn food consumption per capita will decline by about 0.5 percentage point per year starting in 1980, until the growth rate reaches zero and the level of consumption stabilizes. This implies that corn food use per capita will be two-thirds larger in 1990 than in 1979, and that in 1994 corn food use per capita will finally stabilize at an amount three-quarters larger than its 1979 level. This declining growth rate assumption enters the model as follows:

```
IF YEAR LE 1979   THEN   JPLQDCNF  =  - 149.472  +  0.077000073 YEAR

ELSE IF YEAR LE 1994   THEN

  JPLQDCNF  =  LAG1(JPLQDCNF)  +  0.077000073  -  0.005 (YEAR - 1979)

ELSE   JPLQDCNF  =  LAG1(JPLQDCNF)
```

where "LE" means "less than or equal to", and where "LAG1" indicates last year's value.

Figure 3.6
Actual and Estimated Total Barley Food Consumption



Source: Table 3.9

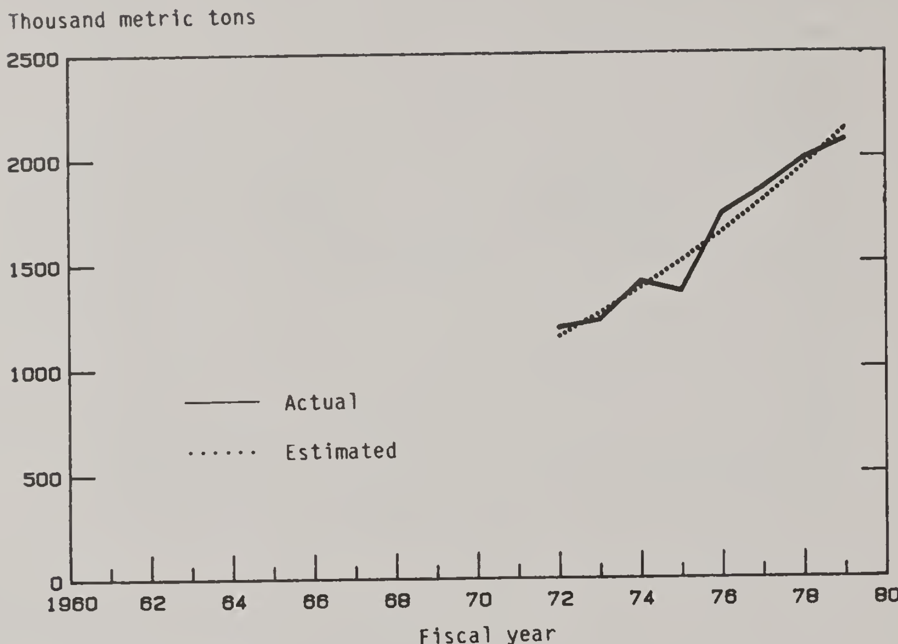
Table 3.9--Actual and estimated total barley food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	1,559	--	--	--
1961	1,212	--	--	--
1962	1,105	--	--	--
1963	965	--	--	--
1964	1,047	--	--	--
1965	1,003	976	27	2.7
1966	995	1,029	-34	-3.4
1967	980	1,020	-40	-4.1
1968	956	957	-1	-0.1
1969	910	895	15	1.6
1970	813	837	-24	-3.0
1971	840	858	-18	-2.1
1972	847	831	16	1.9
1973	988	851	137	13.9
1974	998	934	64	6.4
1975	1,013	1,002	11	1.1
1976	1,010	1,037	-27	-2.7
1977	1,059	1,061	-2	-0.2
1978	1,047	1,072	-25	-2.4
1979	1,031	1,117	-86	-8.3
		Mean absolute value:	35	3.6
		Root mean square:	49	5.0

Sources: Table 3.1 and model estimates.

Figure 3.7

Actual and Estimated Corn Food Consumption



Source: Table 3.10

Table 3.10--Actual and estimated corn food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1972	1,195	1,154	41	3.4
1973	1,228	1,263	-35	-2.9
1974	1,855	1,383	29	2.1
1975	1,364	1,512	-148	-10.9
1976	1,736	1,650	86	5.0
1977	1,144	1,799	56	3.0
1978	1,995	1,960	35	1.8
1979	2,084	2,135	-51	-2.4
		Mean absolute value:	60	3.9
		Root mean square:	71	4.8

Sources: Table 3.1 and model estimates.

OTHER GRAIN

As with corn, there are only 8 observations on the food use of other grain, and this hampers estimation of demand characteristics. A regression on income provides the best fit to the available data (with an adjusted R^2 of 58 percent). However, the estimated income elasticity of 2.8 is unrealistically high, implying an implausible growth rate of 11 percent per year in other grain food demand when combined with a projected growth of 3.9 percent in real income per capita. Despite its much lower adjusted R^2, a simple time trend is deemed to produce more reliable estimates of future consumption, and is adopted in the model:

$$
\begin{array}{lll}
\text{JPLQDOGF} = & -\ 71.800532 & +\ 0.036301028\ \text{YEAR} \\
 & \pm\ 36.080318 & \pm\ 0.018263879 \\
 & (1.990) & (1.988) \\
 & 9.37\% & 9.40\%
\end{array}
$$

Adjusted R^2 = 29.65 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 2.140
Autocorrelation of residuals = -0.090

JPLQDOGF = Japan, logarithm of other grain used as food, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1972 to 1979)

Table 3.11 and Figure 3.8 compare the actual amounts of other grain food consumption to the estimates derived from the regressed time trend.

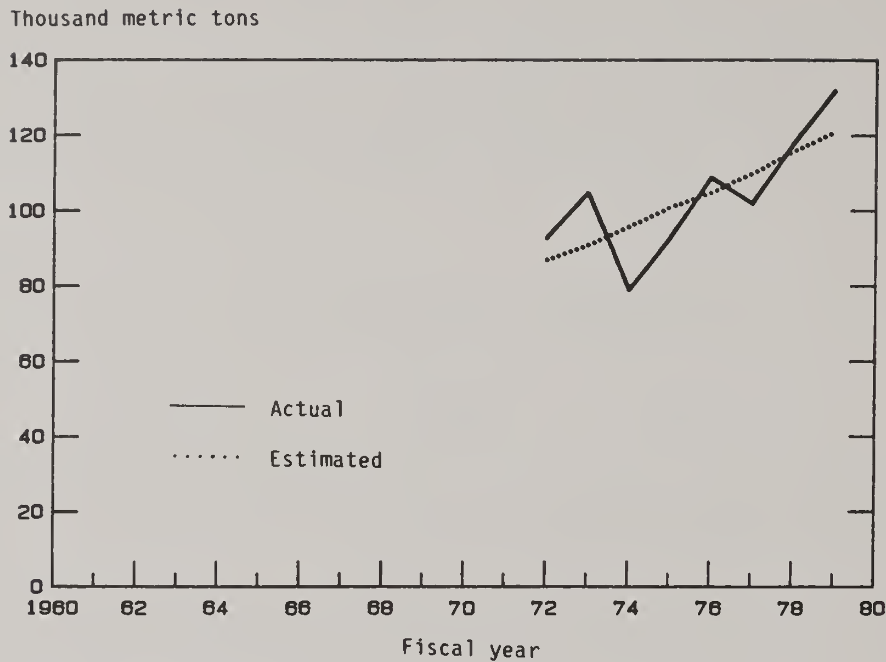
To keep the analysis in perspective, it should be noted that the level of other grain food use was very small during the late seventies, both absolutely (about 1 kilogram per person per year), and in comparison with the level of feed use (which was more than 40 times as great as food use). Thus even a gross overestimate of other grain food use in the year 2000 would have relatively little effect on projections of total use or imports.

COMPENDIUM OF FOOD DEMAND REGRESSION EQUATIONS

This section presents a large set of alternative regression equations for food demand. Any of these equations may be substituted for the corresponding behavioral equation in the model, without having to change any other equation.

The presentation of these alternative regressions serves two purposes. First, it shows the context from which the "best" model equations were extracted, and therefore allows a more informed judgment of the model's validity. 6/ For this purpose, even the worst regression results are reported. Second, the "best" regression equation varies with the question being addressed. Consider as an example the following regression equation for rice food demand (excerpted from Table 3.12):

Figure 3.8
Actual and Estimated Other Grain Food Consumption



Source: Table 3.11

Table 3.11--Actual and estimated other grain food consumption

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1972	93	87	6	6.5
1973	105	91	14	13.3
1974	79	96	-17	-21.5
1975	93	101	-8	-8.6
1976	109	105	4	3.7
1977	102	110	-8	-7.8
1978	118	116	2	1.7
1979	132	121	11	8.3
		Mean absolute value:	9	8.9
		Root mean square:	10	10.6

Sources: Table 3.1 and model estimates.

$$\text{JPLQDRIF} = \underset{\substack{\pm 0.9 \\ (9.5) \\ 0.01\%}}{7.7} - \underset{\substack{\pm 0.06 \\ (7.6) \\ 0.01\%}}{0.41}\ \text{JPLGNPFY} - \underset{\substack{\pm 0.12 \\ (0.59) \\ 57\%}}{0.07}\ \text{JPLPDRIF}$$

Adjusted R^2 = 82.93 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 0.291
Autocorrelation of residuals = 0.738

JPLQDRIF = Japan, logarithm of rice used as food, fiscal year (kilograms per capita, brown basis)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JPLPDRIF = Japan, logarithm of rice resale price, fiscal year (1970 yen per kilogram)

This equation is not used in the model because:

- a simple time trend produces more accurate estimates;

- the price coefficient is not statistically significant (since its significance level--57 percent--is weaker than 50 percent, the price of tomatoes in China would probably be a better predictor of rice consumption in Japan);

- the effects of price changes on Japanese rice consumption can safely be ignored in practice, both because the price elasticity is small, and because for political reasons the government is not about to make major changes in the price it sets for rice.

However the question, "What would happen if the Japanese government allowed the price of rice to fall to its world trade level?" cannot be answered by means of the time trend used in the model. Even when modulated by a very low price elasticity, the effect of such a large price change could not be dismissed as trivial. Thus the equation above (or a similar specification) would have to be used instead.

Many of the regression equations presented in Tables 3.12 through 3.17 violate common sense restrictions or have other undesirable properties. Some warnings are given in the "Comments" column, 7/ but it is up to the analyst to exercise appropriate caution when replacing an equation used in the model with an equation taken from these tables. The possibility of mechanical substitution does not imply its desirability.

Table 3.12--Regression equations for rice food demand

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPDRIF	ln(Cross price) JPLPDWHF	ln(Price ratio) JPLPDWRF	Comments
17.90% 0.250 .648	2.6 ± 1.1 (2.4) 3.0%			0.45 ± .22 (2.0) 6.5%			Wrong sign on price, poor $\overline{R}^2$.
81.08% 1.184 .398	5.6 ± 0.1 (51) 0.01%					0.64 ± .08 (7.8) 0.01%	
93.28% 1.497 .194	4.0 ± 0.3 (12) 0.01%			-0.28 ± .09 (3.2) 0.75%	0.60 ± .05 (12) 0.01%		
83.79% 0.280 .742	7.3 ± 0.3 (24) 0.01%	-0.39 ± .05 (8.6) 0.01%					
82.93% 0.291 .738	7.7 ± 0.9 (8.9) 0.01%	-0.41 ± .06 (7.1) 0.01%		-0.07 ± .12 (0.59) 57%			Insignificant price coefficient.
88.65% 0.688 .573	6.6 ± 0.4 (19) 0.01%	-0.23 ± .07 (3.1) 0.90%				0.31 ± .12 (2.6) 2.5%	
92.88% 1.883 .017	3.3 ± 1.2 (2.8) 1.7%	0.07 ± .12 (0.58) 58%		-0.30 ± .10 (3.1) 1.0%	0.69 ± .16 (4.2) 0.14%		Insignificant income coefficient.
87.95% 0.624 .616	15 ± 3 (4.5) 0.07%	-1.4 ± 0.4 (3.2) 0.74%	-635 ± 271 (2.3) 3.7%				
90.70% 1.086 .417	19 ± 4 (5.5) 0.02%	-1.9 ± 0.4 (4.2) 0.14%	-873 ± 263 (3.3) 0.68%	-0.22 ± .10 (2.1) 5.6%			
94.16% 1.762 .086	15 ± 2 (6.4) 0.01%	-1.3 ± 0.3 (4.2) 0.15%	-663 ± 189 (3.5) 0.49%			0.33 ± .09 (3.7) 0.34%	
94.28% 2.133 -.101	11 ± 4 (2.7) 2.3%	-0.86 ± .50 (1.7) 11%	-479 ± 249 (1.9) 8.3%	-0.32 ± .09 (3.6) 0.46%	0.50 ± .18 (2.8) 1.8%		Weak income coefficient.

Regression statistics	Intercept	Time trend YEAR	Comments
97.83% 0.927 .406	45 ± 2 (28) 0.01%	-0.020 ± .001 (25) 0.01%	EQUATION USED IN MODEL.

(Continues to next page)

(Table 3.12, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDRIF = Japan, logarithm of rice used as food, fiscal year (kilograms per capita, brown basis)

Independent variables:
JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
JPLPDRIF = Japan, logarithm of rice resale price, fiscal year (1970 yen per kilogram)
JPLPDWHF = Japan, logarithm of wheat resale price, fiscal year (1970 yen per kilogram)
JPLPDWRF = Japan, logarithm of resale price ratio, wheat/rice, fiscal year
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 3.13--Regression equations for wheat food demand

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPDWHF	ln(Cross price) JPLPDRIF	ln(Price ratio) JPLPDWRF	Comments
R^2=0; $\bar{R}^2$ n/a 0.517 .608	3.792 $\pm$ 0.004 (819) 0.01%						EQUATION USED IN MODEL.
-7.22% 0.533 .608	3.8 $\pm$ 0.1 (36) 0.01%			-0.01 $\pm$ .03 (0.35) 73%			Insignificant price coefficient and $\bar{R}^2$.
1.10% 0.677 .548	3.73 $\pm$ 0.06 (64) 0.01%					-0.046 $\pm$ .042 (1.1) 31%	Poor price coefficient and $\bar{R}^2$.
-3.48% 0.792 .497	3.6 $\pm$ 0.2 (15) 0.01%			-0.049 $\pm$ .044 (1.1) 29%	0.081 $\pm$ .068 (1.2) 26%		Insignificant $\bar{R}^2$, poor price coefficients.
-8.25% 0.514 .607	3.8 $\pm$ 0.2 (21) 0.01%	-0.003 $\pm$ .028 (0.09) 93%					Insignificant income coefficient and $\bar{R}^2$.
4.98% 0.796 .472	5.3 $\pm$ 0.9 (5.6) 0.01%	-0.15 $\pm$ .09 (1.6) 14%		-0.17 $\pm$ .10 (1.6) 13%			Poor $\bar{R}^2$, weak income and price coefficients.
12.18% 1.153 .338	4.0 $\pm$ 0.2 (20) 0.01%	-0.064 $\pm$ .041 (1.6) 14%				-0.13 $\pm$ .06 (1.9) 7.8%	Poor $\bar{R}^2$, weak income coefficient.
12.40% 1.842 .005	5.4 $\pm$ 0.8 (6.4) 0.01%	-0.19 $\pm$ .08 (2.2) 5.0%		-0.27 $\pm$ .11 (2.5) 3.0%	0.12 $\pm$ .06 (1.9) 8.3%		Poor $\bar{R}^2$.
4.21% 0.837 .488	-0.2 $\pm$ 2.5 (0.10) 93%	0.54 $\pm$ .34 (1.6) 14%	352 $\pm$ 220 (1.6) 14%				Wrong sign on income coefficients, poor $\bar{R}^2$.
1.60% 0.865 .456	2.3 $\pm$ 4.0 (0.58) 58%	0.24 $\pm$ 0.50 (0.48) 64%	217 $\pm$ 275 (0.79) 45%	-0.11 $\pm$ .13 (0.84) 42%			Wrong sign on income coefficients, poor $\bar{R}^2$ and price coefficient.
25.19% 1.595 .159	0.2 $\pm$ 2.3 (0.09) 93%	0.45 $\pm$ 0.30 (1.5) 17%	332 $\pm$ 195 (1.7) 12%			-0.12 $\pm$ .06 (2.0) 7.1%	Wrong sign on income coefficients, weak $\bar{R}^2$.
22.30% 1.854 .016	2.3 $\pm$ 3.5 (0.66) 53%	0.20 $\pm$ 0.44 (0.45) 66%	219 $\pm$ 244 (0.90) 39%	-0.21 $\pm$ .13 (1.7) 13%	0.12 $\pm$ .06 (1.9) 8.8%		Wrong sign on income coefficients, poor $\bar{R}^2$, weak own-price coeff.

Regression statistics	Intercept	Time trend YEAR	Comments
7.28% 0.590 .597	0.7 $\pm$ 2.2 (0.32) 76%	0.0016 $\pm$ .0011 (1.4) 18%	Poor $\bar{R}^2$, weak time coefficient.

(Continues to next page)

(Table 3.13, continued)

All regressions were run over the 14-year interval spanning Japanese fiscal years 1966-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDWHF = Japan, logarithm of wheat used as food, fiscal year (kilograms per capita)

Independent variables:
JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
JPLPDWHF = Japan, logarithm of wheat resale price, fiscal year (1970 yen per kilogram)
JPLPDRIF = Japan, logarithm of rice resale price, fiscal year (1970 yen per kilogram)
JPLPDWRF = Japan, logarithm of resale price ratio, wheat/rice, fiscal year
YEAR = Japanese fiscal year (values from 1966 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 3.14--Regression equations for barley food demand (direct use only)

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPDBAF	ln(Cross price) JPLPDRIF	ln(Price ratio) JPLPDBRF	Comments
82.96% 0.828 .448	-5.9 ± 0.9 (6.9) 0.01%			2.2 ± 0.3 (8.3) 0.01%			Wrong sign on price coefficient.
80.64% 1.369 .251	5.7 ± 0.6 (9.6) 0.01%					3.0 ± 0.4 (7.7) 0.01%	Wrong sign on price coefficient.
86.70% 1.369 .187	-0.8 ± 2.5 (0.30) 77%			2.7 ± 0.3 (7.9) 0.01%	-1.5 ± 0.7 (2.2) 5.2%		Wrong signs on price coefficients.
85.63% 0.662 .445	14 ± 1 (10) 0.01%	-2.0 ± 0.2 (9.2) 0.01%					
85.80 0.705 .440	7.1 ± 6.9 (1.0) 33%	-1.3 ± 0.7 (1.9) 8.2%		0.82 ± .76 (1.1) 30%			Wrong sign on price coefficient.
86.61% 0.862 .365	12 ± 2 (5.0) 0.03%	-1.4 ± 0.5 (2.6) 2.3%				1.1 ± 0.8 (1.4) 19%	Wrong sign on price coefficient.
86.60% 1.036 .297	5.3 ± 6.8 (0.78) 45%	-0.76 ± 0.79 (0.95) 36%		1.8 ± 1.0 (1.7) 12%	-1.1 ± 0.8 (1.3) 22%		Wrong signs on price coefficients, poor income coefficient.
93.71% 1.208 .287	65 ± 12 (5.4) 0.02%	-8.8 ± 1.6 (5.4) 0.02%	-4,217 ± 1,003 (4.2) 0.12%				EQUATION USED IN MODEL.
93.36% 1.360 .220	73 ± 18 (4.1) 0.18%	-9.8 ± 2.3 (4.3) 0.12%	-4,585 ± 1,198 (3.8) 0.28%	-0.36 ± .60 (0.60) 56%			Insignificant price coefficient.
95.99% 2.191 -.164	64 ± 10 (6.6) 0.01%	-8.3 ± 1.3 (6.3) 0.01%	-4,321 ± 801 (5.4) 0.02%			1.2 ± 0.4 (2.8) 1.7%	Wrong sign on price coefficient.
96.10% 2.369 -.238	75 ± 14 (5.5) 0.03%	-9.6 ± 1.7 (5.5) 0.02%	-4,867 ± 923 (5.3) 0.04%	0.75 ± .60 (1.3) 24%	-1.3 ± 0.4 (3.0) 1.4%		Wrong signs on price coefficients.

Regression statistics	Intercept	Time trend YEAR	Comments
90.12% 0.946 .510	199 ± 17 (11) 0.01%	-0.100 ± .009 (11) 0.01%	

(Continues to next page)

(Table 3.14, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDBDF = Japan, logarithm of food barley used directly, fiscal year (kilograms per capita)

Independent variables:
JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
JPLPDBAF = Japan, logarithm of barley resale price, fiscal year (1970 yen per kilogram)
JPLPDRIF = Japan, logarithm of rice resale price, fiscal year (1970 yen per kilogram)
JPLPDBRF = Japan, logarithm of resale price ratio, barley/rice, fiscal year
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 3.15--Regression equations for barley food demand (industrial use only)

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPDBAF	ln(Cross price) JPLPDRIF	ln(Price ratio) JPLPDBRF	Comments
90.42% 0.668 .605	5.7 ± 0.3 (16) 0.01%			-1.2 ± 0.1 (12) 0.01%			
76.59% 1.027 .470	-0.74 ± .35 (2.1) 5.7%					-1.6 ± 0.2 (6.8) 0.01%	
90.77% 0.967 .458	4.3 ± 1.1 (3.8) 0.24%			-1.4 ± 0.2 (8.8) 0.01%	0.37 ± .30 (1.2) 25%		Weak cross-price coefficient.
83.47% 0.328 .743	-5.4 ± 0.8 (6.5) 0.01%	1.1 ± 0.1 (8.5) 0.01%					
89.86% 0.554 .653	4.0 ± 3.2 (1.3) 23%	0.17 ± .31 (0.53) 60%		-1.1 ± 0.3 (3.0) 1.0%			Insignificant income coefficient.
83.48% 0.442 .695	-4.2 ± 1.4 (3.0) 1.1%	0.79 ± .31 (2.5) 2.6%				-0.48 ± .48 (1.0) 33%	Poor price coefficient.
89.94% 1.024 .433	4.6 ± 3.2 (1.5) 17%	-0.04 ± .37 (0.10) 92%		-1.4 ± 0.5 (2.9) 1.5%	0.39 ± .38 (1.0) 32%		Insignificant income coefficient, poor cross-price coefficient.
92.11% 0.709 .636	-34 ± 7 (4.6) 0.06%	4.9 ± 1.0 (5.0) 0.03%	2,367 ± 606 (3.9) 0.21%				Wrong sign on income coefficients.
93.42% 0.630 .667	-21 ± 10 (2.2) 4.8%	3.4 ± 1.2 (2.8) 1.7%	1,762 ± 643 (2.7) 1.9%	-0.60 ± .32 (1.8) 9.3%			Wrong sign on income coefficients.
93.32% 1.058 .449	-33 ± 7 (4.9) 0.05%	4.7 ± 0.9 (5.1) 0.04%	2,413 ± 558 (4.3) 0.12%			-0.54 ± .31 (1.8) 10%	Wrong sign on income coefficients, weak price coefficient.
94.41% 1.406 .280	-22 ± 9 (2.5) 3.2%	3.4 ± 1.1 (3.0) 1.3%	1,867 ± 597 (3.1) 1.1%	-1.0 ± 0.4 (2.6) 2.5%	0.48 ± .28 (1.7) 12%		Wrong sign on income coefficients, weak cross-price coefficient.

Regression statistics	Intercept	Time trend YEAR	Comments
97.03% 1.146 .359	-109 ± 5 (21) 0.01%	0.056 ± .003 (21) 0.01%	EQUATION USED IN MODEL.

(Continues to next page)

(Table 3.15, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDBIF = Japan, logarithm of food barley used industrially, fiscal year (kilograms per capita)

Independent variables:
- JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
- JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
- JPLPDBAF = Japan, logarithm of barley resale price, fiscal year (1970 yen per kilogram)
- JPLPDRIF = Japan, logarithm of rice resale price, fiscal year (1970 yen per kilogram)
- JPLPDBRF = Japan, logarithm of resale price ratio, barley/rice, fiscal year
- YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 3.16--Regression equations for corn food demand

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPTCN	Comments
49.74% 2.679 .222	3.9 $\pm$ 0.4 (8.7) 0.01%			-0.45 $\pm$ .16 (2.8) 3.1%	Weak $\overline{R}^2$.
32.02% 0.893 .677	-18 $\pm$ 10 (1.8) 12%	3.1 $\pm$ 1.5 (2.1) 8.4%			Weak $\overline{R}^2$.
41.61% 2.112 .408	-2 $\pm$ 15 (0.14) 89%	0.9 $\pm$ 2.1 (0.41) 70%		-0.37 $\pm$ 0.26 (1.4) 22%	Insignificant income coefficient, weak price coefficient and $\overline{R}^2$.
26.46% 1.077 .558	-606 $\pm$ 795 (0.76) 48%	79 $\pm$ 103 (0.77) 48%	62,911 $\pm$ 85,105 (0.74) 49%		Wrong sign on income coefficients, weak $\overline{R}^2$.
37.20% 2.696 .075	-594 $\pm$ 735 (0.81) 46%	78 $\pm$ 95 (0.81) 46%	63,350 $\pm$ 78,644 (0.81) 47%	-0.37 $\pm$ 0.27 (1.4) 24%	Wrong sign on income coefficients, weak price coefficient and $\overline{R}^2$.
Regression statistics	**Intercept**	**Time trend YEAR**			**Comments**
92.33% 2.937 -.448	-149 $\pm$ 16 (9.1) 0.01%	0.077 $\pm$ .008 (9.2) 0.01%			EQUATION USED IN MODEL (with modification).

All regressions were run over the 8-year interval spanning Japanese fiscal years 1972-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDCNF = Japan, logarithm of corn used as food, fiscal year (kilograms per capita)

Independent variables:
- JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
- JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
- JPLPTCN = Japan, logarithm of corn trade price, calendar year (1970 yen per kilogram)
- YEAR = Japanese fiscal year (values from 1972 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 3.17--Regression equations for other grain food demand

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Own price) JPLPTSG	Comments
41.72% 2.872 -.507	0.78 ± .36 (2.2) 7.1%			-0.32 ± .13 (2.5) 5.0%	Weak $\overline{R}^2$.
58.33% 2.314 -.165	-19 ± 6 (3.3) 1.6%	2.8 ± 0.9 (3.3) 1.7%			
52.84% 2.638 -.330	-15 ± 10 (1.5) 20%	2.2 ± 1.4 (1.6) 18%		-0.10 ± .18 (0.55) 61%	Insignificant price coefficient, weak income coefficient.
51.30% 2.334 -.169	-190 ± 468 (0.41) 70%	25 ± 61 (0.41) 70%	18,330 ± 50,083 (0.37) 73%		Wrong sign on insignificant income coefficients.
42.73% 2.668 -.337	-189 ± 507 (0.37) 73%	25 ± 66 (0.38) 73%	18,645 ± 54,316 (0.34) 75%	-0.10 ± .20 (0.50) 64%	Wrong sign on income coefficients, all coefficients insignificant, weak $\overline{R}^2$.
Regression statistics	Intercept	Time trend YEAR			Comments
29.65% 2.140 -.090	-72 ± 36 (2.0) 9.4%	0.036 ± .018 (2.0) 9.4%			EQUATION USED IN MODEL. Weak $\overline{R}^2$.

All regressions were run over the 8-year interval spanning Japanese fiscal years 1972-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQDOGF = Japan, logarithm of other grain used as food, fiscal year (kilograms per capita)

Independent variables: JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)

JPLPTSG = Japan, logarithm of sorghum trade price, calendar year (1970 yen per kilogram)

YEAR = Japanese fiscal year (values from 1972 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

1/ In the log-log-inverse function, the income elasticity of demand equals $(b_1 - b_2/y)$, where y is real income per capita, and where b_1 and b_2 are both negative. This and other functional forms are discussed by L.M. Goreux in "Income and Food Consumption," Monthly Bulletin of Agricultural Economics and Statistics, Food and Agriculture Organization of the United Nations (Vol. IX, No. 10, October 1960), pages 1-13.

2/ Statistical analysis was implemented with Versions 79.5 and 79.6 of the Statistical Analysis System (SAS) computer package. Most regressions were estimated using the REG procedure. (See the SAS User's Guide: 1979 Edition and SAS Technical Report P-115: SAS 79.5 Changes and Enhancements, both published by the SAS Institute, Inc., Box 8000, Cary, N.C. 27511.) To get the SAS program to print additional digits, regressions including a time trend were rerun with the YEAR variable divided by 1,000.

3/ This is confirmed by regressions on various combinations of income and prices (reported in Table 3.13), which often have negative adjusted R^2 statistics. In the only two regression equations featuring adjusted R^2 statistics above 20 percent, two of the coefficients have the wrong sign. The regressed time trend (analogous to the rice equation presented above) indicates an annual growth rate of less than one-sixth percent during 1966-79.

4/ The parameters for this equation are obtained by regressing JPLQDWHF on a dummy variable always set equal to 1, without a separate intercept term. Under these circumstances, the unadjusted R^2 statistic is equal to zero by definition. The term on the right of the equation is the arithmetic average of the logarithm of per capita wheat consumption; so taking the exponential of both sides sets per capita wheat consumption equal to its geometric average value.

5/ A somewhat more complex assumption for income growth underlies the model's projections in Chapter Eight.

6/ The liability incurred when an author does not report unused regression equations is described by Thomas F. Cooley and Stephen F. LeRoy in their article, "Identification and Estimation of Money Demand," American Economic Review (Vol. 71, No. 5, December 1981). They state (page 826):

> Acting as an advocate for his theory, the economist conducting an empirical study is motivated to examine all or a large subset of the many possible regressions constituting tests of his theory and to report only those results most favorable to his theory.... The reader, of course, knowing that a specification search underlies the reported tests, discounts heavily or completely the researcher's claims for validation of a theory for which he is obviously acting as an advocate.... We often have what is very nearly a zero-communication information equilibrium. The researcher has the motive and opportunity to represent his results selectively, and the reader, knowing this, imputes a low or zero signal-to-noise ratio to the reported results.

7/ The following standards are used in comments: An adjusted R^2 statistic is called "weak" if below 50 percent, "poor" if below 25 percent, and "insignificant" if below 0 percent. A coefficient is called "weak" if its significance level is above 10 percent, "poor" if its significance level is above 25 percent, and "insignificant" if its significance level is above 50 percent. However, when a coefficient has the wrong sign no comment is made on its significance level. The appropriate signs are that both income terms in a log-log-inverse functional form be negative, that the own-price coefficient be negative, that the cross-price coefficient be positive, and that the sign of the relative price coefficient imply a reduction in the demand for a commodity when its own price rises relative to the (cross) price of a substitute product.

CHAPTER FOUR

FEED

SUMMARY

The feed demand block of the Japanese Grains Model is based on three behavioral equations. The first estimates total feedgrain demand per capita as a function of income per capita (in constant yen) and the average trade price of the dominant feedgrains (also in constant yen). The second behavioral equation splits the total into wheat feed and nonwheat feed, using a simple time trend. The third equation splits nonwheat feed into other coarse grains feed and rice plus corn feed, as a function of the ratio of the sorghum trade price to the corn trade price. The amount of rice feed is trivial, except when the government heavily subsidizes its substitution for corn feed in order to reduce surplus stocks. For now, rice feed is treated as an exogenous policy variable. This allows an identity to split rice plus corn feed into its components. (The policy-set quantity of rice feed will become endogenous in Chapters Seven and Eight.)

The first behavioral equation produces estimates measured in terms of the logarithm of kilograms per capita. An identity transforms these figures into the estimated national total measured in thousand metric tons. The second and third behavioral equations estimate the logarithms of ratios (for example, the logarithm of the ratio of wheat feed to nonwheat feed). Six identities transform the estimated logarithms of ratios into the implied quantities of feed measured in thousand metric tons.

Equation numbers continue from Chapter Three.

<u>Behavioral Equations</u>:

[15] JPLQFTGF = - 1.385511 + 1.001456 * JPLGNPFY - 0.192669 * JPLPTCO

[16] JPLQFWNW = 119.482 - 0.062005509 * YEAR

[17] JPLFBORC = - 0.267836 - 1.951884 * JPLPTSCN

<u>Identities</u>:

[18] JPQFTGFY = ROUND(JPPOPFY * EXP(JPLQFTGF) / 1000)

[19] JPQFWNWF = EXP(JPLQFWNW)

[20] JPQFWHFY = ROUND(JPQFTGFY * JPQFWNWF / (1.0 + JPQFWNWF))

[21] JPQFNWFY = JPQFTGFY - JPQFWHFY

[22] JPQFBORC = EXP(JPLFBORC)

[23] JPQFCGFY = ROUND(JPQFNWFY * JPQFBORC / (1.0 + JPQFBORC))

[24] JPQFRCFY = JPQFNWFY - JPQFCGFY

[25] JPQFCNFY = JPQFRCFY - JPQFRIFY

where:

* indicates multiplication

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

and where:

JPQFaaFY = Japan, quantity of aa used as feed, fiscal year (thousand metric tons); with aa from the list:

TG = total grain
WH = wheat
NW = nonwheat grains
CG = other coarse grains
RC = rice plus corn
CN = corn
RI = rice

JPLQFTGF = Japan, logarithm of total grain used as feed, fiscal year (kilograms per capita)

JPLQFWNW = Japan, logarithm of ratio: (wheat feed) / (nonwheat feed), fiscal year

JPLFBORC = Japan, logarithm of ratio: (barley + other grain feed) / (rice + corn feed), fiscal year

JPQFWNWF = Japan, ratio: (wheat feed) / (nonwheat feed), fiscal year

JPQFBORC = Japan, ratio: (barley + other grain feed) / (rice + corn feed), fiscal year

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JPLPTCO = Japan, logarithm of trade price average, 60 percent corn plus 40 percent sorghum, calendar year (1970 yen per kilogram)

JPLPTSCN = Japan, logarithm of trade price ratio: (sorghum) / (corn), calendar year

YEAR = Japanese fiscal year (for example, 1979)

REVIEW OF DATA

Data on the feed use of grains, collected from various tables in Chapter Two, are brought together in Table 4.1 below. Table 4.2 shows the percent of the total feedgrain weight contributed by each cereal in each year. Before 1972, the food balance sheets published in the Statistical Yearbook of the Ministry of Agriculture and Forestry did not separate corn from other grain (where "other grain" is defined as total grain minus rice, wheat, barley, and corn).

Table 4.1--Quantities of grain used as feed

Fiscal year	Rice	Wheat	Barley	Corn	Other grain	Corn plus other grain	Total
	Thousand metric tons						
1960	20	468	540	--	--	1,739	2,767
1961	20	616	981	--	--	2,374	3,991
1962	20	646	836	--	--	2,872	4,374
1963	32	520	497	--	--	3,637	4,686
1964	20	534	648	--	--	4,004	5,206
1965	20	530	665	--	--	4,712	5,927
1966	28	543	693	--	--	5,827	7,091
1967	26	592	737	--	--	6,017	7,372
1968	26	567	738	--	--	6,649	7,980
1969	26	667	785	--	--	7,416	8,894
1970	274	701	862	--	--	8,939	10,776
1971	1,490	632	898	--	--	8,174	11,194
1972	1,265	707	982	5,276	4,029	9,305	12,259
1973	496	708	1,133	6,142	4,065	10,207	12,544
1974	13	619	1,129	6,349	4,607	10,956	12,717
1975	10	590	1,176	6,263	4,102	10,365	12,141
1976	12	576	1,238	6,841	4,866	11,707	13,533
1977	9	637	1,288	7,578	5,376	12,954	14,888
1978	8	669	1,325	8,486	5,376	13,862	15,864
1979	7	683	1,420	9,256	5,807	15,063	17,173

Note: The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Taken from Tables 2.1 through 2.6, which in turn are based on Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions, and its revised Food Balance Sheets: 1955-1966.

Table 4.2--Distribution of grain used as feed

Fiscal year	Rice	Wheat	Barley	Corn	Other grain	Corn plus other grain
			Percent of total			
1960	0.7	16.9	19.5	--	--	62.8
1961	0.5	15.4	24.6	--	--	59.5
1962	0.5	14.8	19.1	--	--	65.7
1963	0.7	11.1	10.6	--	--	77.6
1964	0.4	10.3	12.4	--	--	76.9
1965	0.3	8.9	11.2	--	--	79.5
1966	0.4	7.7	9.8	--	--	82.2
1967	0.4	8.0	10.0	--	--	81.6
1968	0.3	7.1	9.2	--	--	83.3
1969	0.3	7.5	8.8	--	--	83.4
1970	2.5	6.5	8.0	--	--	83.0
1971	13.3	5.6	8.0	--	--	73.0
1972	10.3	5.8	8.0	43.0	32.9	75.9
1973	4.0	5.6	9.0	49.0	32.4	81.4
1974	0.1	4.9	8.9	49.9	36.2	86.2
1975	0.1	4.9	9.7	51.6	33.8	85.4
1976	0.1	4.3	9.1	50.6	36.0	86.5
1977	0.1	4.3	8.7	50.9	36.1	87.0
1978	0.1	4.2	8.4	53.5	33.9	87.4
1979	0.0	4.0	8.3	53.9	33.8	87.7

Notes: Due to rounding, percentages may not add up to 100.

The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Calculated from data in Tables 2.1 through 2.6, which in turn are based on Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966.

Table 4.1 contains all the data (except population) used to calculate the dependent variables for the feed regression equations in the model. Additional information was used to test alternate regression equation specifications, which ultimately were not adopted. But the reasons for which these alternative specifications were rejected are of interest, if only to avoid blind alleys.

In Table 4.1 and in the model, it is implicitly assumed that metric tons of rice, wheat, barley, corn, and other grain (mostly sorghum) are all equivalent, so that they can be aggregated into total grain used as feed. In fact, different grains are neither equally nutritious nor equally digestible. Therefore all grain quantity statistics were transformed from thousand metric tons into thousand tons of corn equivalent, using the conversion factors shown in Table 4.3. Conversion to corn-equivalent weights usually improved the fit of the regression equations. But the difference was so small--typically half a percentage point gain in adjusted R^2--that the improvement was judged not to be worth the additional computational complexity. Part of the problem is that the conversion factors are only approximate, since the nutritional value of a particular grain depends upon the kind of animal eating it and upon the other ingredients in its feed. The corn conversion factors used here are based on the livestock mix and feeding practices in the United States instead of those in Japan.

Statistics on formula feed were used to extend the corn series and the other grain series back over the span 1962-71. The food balance sheets in the MAF Statistical Yearbook contain data only on the sum of corn plus other grain before 1972. This total is close to the sum of the equivalent cereals reported as inputs to production in MAF's formula feed tables; and since 1972, the quantities of both corn and other grain reported in the food balance sheets have been close to their equivalents as reported in the formula feed tables. 1/ So it takes just a hop of faith to split the corn plus other grain total from the food balance sheets in the same ratio as reported for the components of that total in the formula feed tables, during the years before 1972. Table 4.4 shows all the calculations. (Sorghum comprised from 89 percent to 96 percent of other grain between 1965 and 1979, according to the formula feed tables.) The regression equation used in the model to separate corn from other coarse grains is based only on 1972-79 data obtained directly from the food balance sheets. However, regressions spanning the period 1965-79 (and thus including statistics from Table 4.4) were used as background material to help choose among the alternative regression specifications estimated over the shorter period.

MODELING APPROACH

A challenge for a stand-alone grains model is to estimate feed demand without requiring any information on the number of animals or on the consumption of livestock products. Demand for dairy products and meats rises with per capita income. Demand for livestock products is also affected by price, which in turn is a function of the costs of production. Production costs depend to a large extent on expenditures for feedgrains. These expenditures, of course, are the product of the price of feedgrains and the quantity of grain consumed per unit of meat, eggs, or milk produced. During the process of a country's agricultural development, the ratio of feedgrain input to livestock product output typically rises at an early stage, when production shifts from small farms (where animals are fed farm wastes and allowed to forage) to large

Table 4.3--Conversion factors for corn-equivalents

Commodity	Corn-equivalent tons per metric ton
Rice	0.93
Wheat	1.05
Barley	0.90
Corn	1.00
Other grain a/	0.95
Corn + other grain b/	0.98

Notes:

a/ Sorghum conversion factor.

b/ Conversion factor used for Japanese fiscal years 1960-71. Since JFY 1972, the total is obtained as the sum of its two parts.

Sources:

George C. Allen, Earl F. Hodges, and Margaret Devers, Livestock-Feed Relationships: National and State (Statistical Bulletin No. 530, Economic Research Service, U.S. Dept. of Agriculture, June 1974), pages 188-89; except for rice conversion factor, personal communication, George C. Allen.

Table 4.4--Comparison of statistics from Japanese food balance sheets (FBS) and formula feed tables (FFT)

Fiscal year	Corn			Other grain			Total = corn + other grain			(FFT corn / FFT total	Calculated FBS disaggregation	
	FBS	FFT	FBS/FFT	FBS	FFT	FBS/FFT	FBS	FFT	FBS/FFT		Corn	Other grain
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	1000 metric tons		Ratio	1000 metric tons		Ratio	1000 metric tons		------ Ratio ------		-- 1000 metric tons --	
1960	--	1,371	--	--	--	--	1,739	--	--	--	--	--
1961	--	1,857	--	--	--	--	2,374	--	--	--	--	--
1962	--	2,286	--	--	446	--	2,872	2,732	1.05	0.83675	2,403	469
1963	--	2,583	--	--	836	--	3,637	3,419	1.06	0.75548	2,748	889
1964	--	3,016	--	--	1,141	--	4,004	4,157	0.96	0.72552	2,905	1,099
1965	--	2,869	--	--	1,689	--	4,712	4,558	1.03	0.62944	2,966	1,746
1966	--	3,233	--	--	2,477	--	5,827	5,710	1.02	0.56620	3,299	2,528
1967	--	3,313	--	--	2,713	--	6,017	6,026	1.00	0.54978	3,308	2,709
1968	--	4,284	--	--	2,374	--	6,649	6,658	1.00	0.64344	4,278	2,371
1969	--	4,765	--	--	3,108	--	7,416	7,873	0.94	0.60523	4,488	2,928
1970	--	4,417	--	--	4,439	--	8,939	8,856	1.01	0.49876	4,458	4,481
1971	--	3,949	--	--	3,981	--	8,174	7,930	1.03	0.49798	4,071	4,103
1972	5,276	5,232	1.01	4,029	4,022	1.00	9,305	9,254	1.01	0.56538	--	--
1973	6,142	6,332	0.97	4,065	4,222	0.96	10,207	10,554	0.97	0.59996	--	--
1974	6,349	6,093	1.04	4,607	4,493	1.03	10,956	10,586	1.03	0.57557	--	--
1975	6,263	6,263	1.00	4,102	4,214	0.97	10,365	10,477	0.99	0.59779	--	--
1976	6,841	6,787	1.01	4,866	4,898	0.99	11,707	11,685	1.00	0.58083	--	--
1977	7,578	7,351	1.03	5,376	5,294	1.02	12,954	12,645	1.02	0.58134	--	--
1978	8,486	8,164	1.04	5,376	5,361	1.00	13,862	13,525	1.02	0.60362	--	--
1979	9,256	8,934	1.04	5,807	5,801	1.00	15,063	14,735	1.02	0.60631	--	--

Sources by column:

(1), (4), (7): Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966.

(2), (5), (8): Japan Feedstuff Association, Shiryo Geppo [Feed Monthly], pages 44-49 in the June 1981 edition and the equivalent table in earlier June issues. William T. Coyle, in Japan's Feed-Livestock Economy: Prospects for the 1980's (Foreign Agricultural Economic Report No. 177, Economic Research Service, U.S. Dept. of Agriculture, February 1983) reprints this data as Appendix Tables 4-8.

(3): Calculated as (3) = (1) / (2).

(6): Calculated as (6) = (4) / (5).

(9): Calculated as (9) = (7) / (8).

(10): Calculated as (10) = (2) / (8).

(11): Calculated as (11) = (7) x (10), rounded to the nearest thousand metric tons. (Calculation superfluous after 1972.)

(12): Calculated as (12) = (7) - (11). (Calculation superfluous after 1972.)

commercial operations (which must rely on purchased feed). In a second stage, when large commercial operations dominate production, the feed/output ratio falls, due to improvements in the efficiency of animal technology.

Thus the total demand for feedgrains can be reduced to a function of income per capita, the price of feedgrains, and the passage of time (as a proxy for changes in technology). Income per capita should be positively correlated with feedgrain demand. The price of feedgrains should be negatively correlated with feedgrain demand (both because higher feedgrain costs push up the prices of animal products, dampening demand for those foods, and because higher feedgrain prices encourage substitution towards nongrain feeds). The relationship between time (as a proxy for technology) and feedgrain consumption may be highly nonlinear, as one kind of livestock after another first makes the transition from by-product-fed barnyard production to grain-fed large scale production, and afterwards benefits from gradual improvements in animal husbandry.

The model's feed sector starts by estimating total feedgrain demand per capita as a function of real income per capita, real feedgrain prices, and time. The functional forms used in this chapter to estimate the derived total demand for feed are the same as the functional forms used in Chapter Three to estimate the direct demand for food; except that here a time trend was measured not only by itself, but also in combination with economic variables. Specifically, the regression equations tested as estimators of total feed demand were variants of the form:

$$\begin{aligned} \text{LOG}\left(\frac{\text{Total grain used as feed}}{\text{Population}}\right) = \; & a \\ & + b_1 \text{ LOG}\left(\frac{\text{GNP / Population}}{\text{Consumer price index}}\right) \\ & + b_2 \left(\frac{\text{Consumer price index}}{\text{GNP / Population}}\right) \\ & + c \text{ LOG}\left(\frac{\text{Price of feedgrains}}{\text{Consumer price index}}\right) \\ & + d \text{ (Year)} \end{aligned}$$

where "LOG" is the natural logarithm operator. Regression equations were assayed with total grain measured either in metric tons or in corn-equivalent tons. Depending on the functional form being tested, different combinations of parameters were set equal to zero. Whenever the coefficient b_2 was not set equal to zero (that is, whenever a log-log-inverse functional form was specified), then both b_1 and b_2 were expected to be negative.

The price of feedgrains is measured by a weighted average of the trade prices of corn and sorghum. These two grains dominate Japanese feed; they are imported duty-free; and Japanese production is almost negligible. The weights in the average are 60 percent for corn and 40 percent for sorghum, the ratio of corn feed to other grain feed in recent years. Since the trade prices of corn and sorghum tend to move in parallel, the movement of the weighted average price series is scarcely sensitive to the weights chosen.

The model next allocates total feedgrain demand among individual grains.

An institutional peculiarity of Japan now should be noted. Rice normally forms a trivial part of the feedgrain total. In a few years, when the government subsidized rice feeding to dispose of old surplus stocks, rice accounted for a substantial share of feedgrains, peaking at 13 percent in 1971. During those years, feed rice was priced to be competitive with corn; the government stated that it was intended to replace corn; and econometric evidence indicates that it did substitute for corn (as distinct from other coarse grains). 2/ So in this chapter, rice feed is treated as a substitute for corn.

The first step in splitting up the feedgrain total is to separate wheat from coarse grains plus rice.

The ratio of wheat feed to nonwheat feed was assumed to depend on the ratio of the wheat prices to coarse grain prices, and to depend on time. The price of wheat was measured either as the trade price or as the government-set resale price; the price of coarse grains was measured as the average corn-sorghum trade price discussed above. A "logit" functional form was tested, with various combinations of its parameters set equal to zero:

$$\mathrm{LOG}\left(\frac{\text{Wheat feed}}{\text{Nonwheat feed}}\right) = a + b\ \mathrm{LOG}\left(\frac{\text{Wheat price}}{\text{Coarse grains price}}\right) + c\ (\text{Year})$$

Subsequently a similar logit specification was used to split nonwheat feed into (barley plus other grain) versus (rice plus corn). The sum of the Japanese Grains Model categories barley and other grain is identical to the GOL Model category other coarse grains. Since sorghum is by far the largest component of other coarse grains, and since feed rice, when subsidized, is priced like corn, the price variable in the regression equations is the ratio of the trade prices of sorghum and corn. So the regression equations tested were variants of the form:

$$\mathrm{LOG}\left(\frac{\text{Other coarse grains feed}}{\text{Rice feed + Corn feed}}\right) = a + b\ \mathrm{LOG}\left(\frac{\text{Sorghum price}}{\text{Corn price}}\right) + c\ (\text{Year})$$

It was not considered worthwhile to disaggregate other coarse grains feed into barley feed and other grain feed. Because barley is a very close substitute for other coarse grain feeds, the 8 years of food balance sheet data available are insufficient to reliably estimate the subtle distinction involved. And since the Japanese use almost all domestically grown barley as food, feed demand has no significant effect on production.

Rice use as feed is either negligible or the result of a government program. Its analysis is deferred until Chapter Seven, whose subject is government policies. For now, rice feed is treated as an exogenous policy variable, whose value is given by a process outside the model.

TOTAL GRAIN USED AS FEED

Various permutations of the regression equation form presented in the previous section were tested. Because of multicollinearity and the limited number of observations (15), no more than two or three variables were significant in any one regression equation. Four regression equation specifications, in both their metric-weight and corn-equivalent-weight variants, gave about equally accurate estimates, as shown in Table 4.5. The log-log-inverse equations were

Table 4.5--Summary statistics from regression equations for feedgrain demand

Explanatory variables	Adjusted R^2: Using metric tons	Adjusted R^2: Using corn-equivalent tons
	Percent	
log(Income per capita), Year	97.35	97.19
log(Income per capita), log(Price)	95.46	95.45
log(Income per capita), 1/(Income per capita)	96.04	96.06
log(Income per capita), 1/(Income per capita), log(Price)	96.98	96.93

Source: Model estimates.

rejected because their income coefficients were not both negative, as required for that functional form to predict reasonable behavior over a wide range of incomes. From the remaining specifications, the equations with terms in income and price were selected despite their slightly lower adjusted R^2 statistics--first because these equations permit at least a rudimentary economic analysis, and second because the other equations are based on the relationship between time and the derived demand for feedgrains, which is theoretically ambiguous as explained in the previous section. Finally, the specification in metric tons was chosen, since a gain of one-hundredth percentage point in adjusted R^2 was judged not to warrant the extra calculations required to convert to corn-equivalent tons. Thus the model uses the regression equation:

$$
\begin{array}{lllll}
\text{JPLQFTGF} = & -\ 1.385511 & +\ 1.001456\ \text{JPLGNPFY} & -\ 0.192669 & \text{JPLPTCO} \\
 & \pm\ 0.744428 & \pm\ 0.091069 & \pm\ 0.069349 & \\
 & (1.861) & (10.997) & (2.778) & \\
 & 8.74\% & 0.01\% & 1.67\% &
\end{array}
$$

Adjusted R^2 = 95.45 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 1.421
Autocorrelation of residuals = 0.220

JPLQFTGF = Japan, logarithm of total grain used as feed, fiscal year (kilograms per capita)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JPLPTCO = Japan, logarithm of trade price average, 60 percent corn plus 40 percent sorghum, calendar year (1970 yen per kilogram)

Following previous usage, the first line shows coefficients; the second, their standard errors; the third, the absolute value of the t-statistics; and the fourth, the significance levels attained.

The estimates provided by the regression equation are converted from the logarithm of kilograms per capita into the implied national total in thousand metric tons, by means of the equation:

JPQFTGFY = ROUND(JPPOPFY * EXP(JPLQFTGF) / 1000)

where:

* indicates multiplication

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

and where:

JPQFTGFY = Japan, total grain used as feed, fiscal year (thousand metric tons)

JPLQFTGF = Japan, logarithm of total grain used as feed, fiscal year (kilograms per capita)

JPPOPFY = Japan, population on October 1 (thousands)

with the estimated values of JPQFTGFY rounded off to the nearest thousand metric tons. This equation models total feedgrain demand on the basis of the estimated value of the endogenous variable JPLQFTGF and the actual value of the exogenous variable JPPOPFY.

Figure 4.1 and Table 4.6 compare the actual and estimated total quantities of grain used as feed.

WHEAT FEED VERSUS NONWHEAT FEED

Price turned out to be a poor predictor of the ratio of wheat feed to nonwheat feed. But a simple time trend gives a very good fit, as specified in the regression equation below:

$$
\begin{array}{lll}
\text{JPLQFWNW} = & 119.482 & - \; 0.062005509 \text{ YEAR} \\
 & \pm \; 6.417 & \pm \; 0.003254165 \\
 & (18.619) & (19.054) \\
 & 0.01\% & 0.01\%
\end{array}
$$

Adjusted R^2 = 96.28 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 2.433
Autocorrelation of residuals = -0.260

JPLQFWNW = Japan, logarithm of ratio: (wheat feed) / (nonwheat feed), fiscal year

YEAR = Japanese fiscal year (values from 1965 to 1979)

The estimated values of the logarithm of this ratio are converted into the estimated values of the ratio itself, by means of the obvious identity:

JPQFWNWF = EXP(JPLQFWNW)

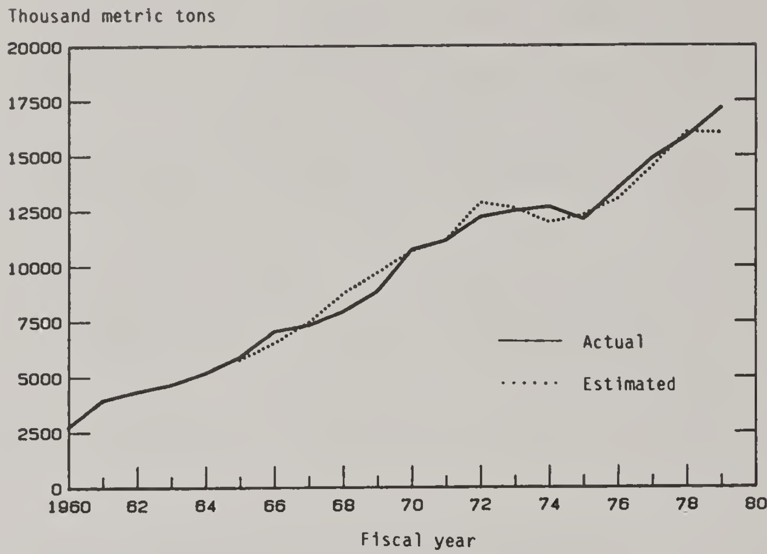
where:

EXP is the exponentiation (e^x) operator

JPQFWNWF = Japan, ratio: (wheat feed) / (nonwheat feed), fiscal year

JPLQFWNW = Japan, logarithm of ratio: (wheat feed) / (nonwheat feed), fiscal year

Figure 4.1
Actual and Estimated Total Grain Used as Feed



Source: Table 4.6

Table 4.6--Actual and estimated total grain used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	2,767	--	--	--
1961	3,991	--	--	--
1962	4,374	--	--	--
1963	4,686	--	--	--
1964	5,206	--	--	--
1965	5,927	5,796	131	2.2
1966	7,091	6,549	542	7.6
1967	7,372	7,498	-126	-1.7
1968	7,980	8,781	-801	-10.0
1969	8,894	9,732	-838	-9.4
1970	10,776	10,718	58	0.5
1971	11,194	11,204	-10	-0.1
1972	12,259	12,909	-650	-5.3
1973	12,544	12,653	-109	-0.9
1974	12,717	11,997	720	5.7
1975	12,141	12,350	-209	-1.7
1976	13,533	13,071	462	3.4
1977	14,888	14,524	364	2.4
1978	15,864	16,067	-203	-1.3
1979	17,173	16,036	1,137	6.6
		Mean absolute value:	424	3.9
		Root mean square:	539	5.1

Sources: Table 4.1 and model estimates.

Then the estimated tonnage of wheat used as feed is obtained by means of the following equation:

JPQFWHFY = ROUND(JPQFTGFY * JPQFWNWF / (1.0 + JPQFWNWF))

where:

* indicates multiplication

ROUND(x) rounds off "x" to the nearest integer

JPQFWHFY = Japan, wheat used as feed, fiscal year (thousand metric tons)

JPQFTGFY = Japan, total grain used as feed, fiscal year (thousand metric tons)

JPQFWNWF = Japan, ratio: (wheat feed) / (nonwheat feed), fiscal year

with the estimate rounded off to the nearest thousand metric tons. 3/ Note that estimated (as distinct from actual) values for JPQFTGFY and JPQFWNWF are used in the equation which models wheat feed.

Finally, the estimated quantity of nonwheat feed is obtained from the estimated quantity of total grain feed and the estimated quantity of wheat feed, by means of the identity:

JPQFNWFY = JPQFTGFY - JPQFWHFY

where:

JPQFNWFY = Japan, nonwheat grains used as feed, fiscal year (thousand metric tons)

JPQFTGFY = Japan, total grain used as feed, fiscal year (thousand metric tons)

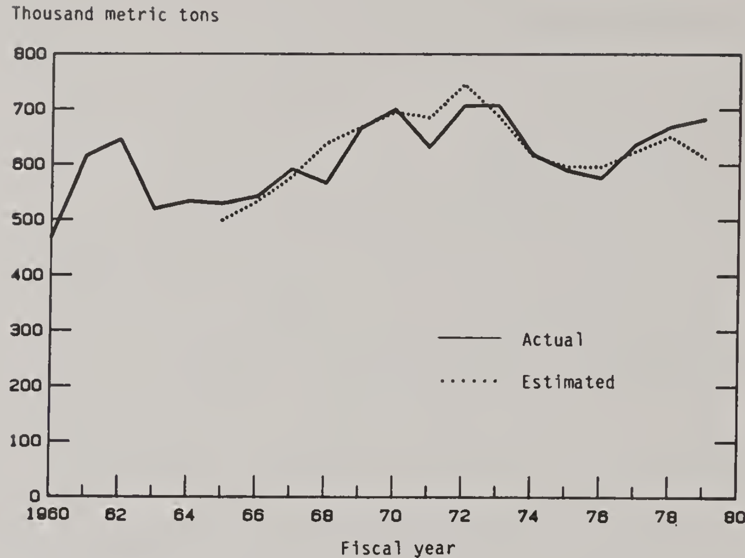
JPQFWHFY = Japan, wheat used as feed, fiscal year (thousand metric tons)

Figure 4.2 and Table 4.7 compare actual and estimated wheat feed. Figure 4.3 and Table 4.8 compare actual and estimated nonwheat feed.

There remains the question: why was the use of wheat feed so insensitive to price? The answer lies in the details of the calculations behind the food balance sheets and in the particulars of Japan's policy to subsidize bran feed.

Since 1959, the Japanese government has subsidized flour mills to produce what might be called, for lack of a better term, "augmented bran". 4/ That is, low-quality wheat is milled to yield 45 percent or 40 percent flour and 55 percent or 60 percent bran product, instead of the usual milling rate of about 78 percent flour and 22 percent bran.

Figure 4.2
Actual and Estimated Wheat Used as Feed



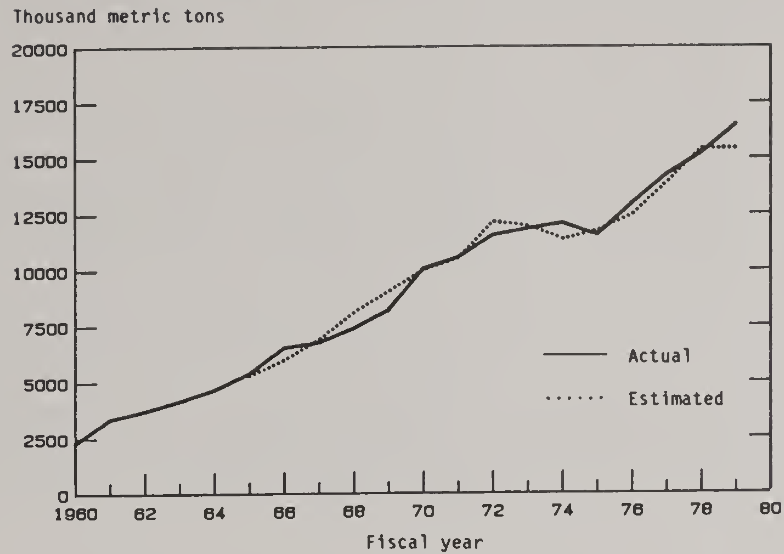
Source: Table 4.7

Table 4.7--Actual and estimated wheat used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1960	468	--	--	--
1961	616	--	--	--
1962	646	--	--	--
1963	520	--	--	--
1964	534	--	--	--
1965	530	500	30	5.7
1966	543	534	9	1.7
1967	592	578	14	2.4
1968	567	639	-72	-12.7
1969	667	668	-1	-0.1
1970	701	695	6	0.9
1971	632	685	-53	-8.4
1972	707	745	-38	-5.4
1973	708	688	20	2.8
1974	619	616	3	0.5
1975	590	597	-7	-1.2
1976	576	596	-20	-3.5
1977	637	624	13	2.0
1978	669	651	18	2.7
1979	683	612	71	10.4
		Mean absolute value:	25	4.0
		Root mean square:	34	5.4

Sources: Table 4.1 and model estimates.

Figure 4.3
Actual and Estimated Non-Wheat Grain Used as Feed



Source: Table 4.8

Table 4.8--Actual and estimated non-wheat grain used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	2,299	--	--	--
1961	3,375	--	--	--
1962	3,728	--	--	--
1963	4,166	--	--	--
1964	4,672	--	--	--
1965	5,397	5,296	101	1.9
1966	6,548	6,015	533	8.1
1967	6,780	6,920	-140	-2.1
1968	7,413	8,142	-729	-9.8
1969	8,227	9,064	-837	-10.2
1970	10,075	10,023	52	0.5
1971	10,562	10,519	43	0.4
1972	11,552	12,164	-612	-5.3
1973	11,836	11,965	-129	-1.1
1974	12,098	11,381	717	5.9
1975	11,551	11,753	-202	-1.7
1976	12,957	12,475	482	3.7
1977	14,251	13,900	351	2.5
1978	15,195	15,416	-221	-1.5
1979	16,490	15,424	1,066	6.5
		Mean absolute value:	414	4.1
		Root mean square:	519	5.2

Sources: Table 4.1 and model estimates.

The food balance sheets apparently include under feed the wheat equivalent of the reduction in flour output attributable to the lower-than-standard milling rate. For example, 1,180 thousand metric tons of wheat were milled at a 45 percent flour yield in 1979, when the normal yield was 78 percent. The consequent reduction in flour output was (0.78 - 0.45) x 1,180 = 389 thousand tons of flour. The wheat equivalent of that lost flour, at the ordinary milling rate, was 389 / 0.78 = 499 thousand tons of wheat. The 499 thousand tons of wheat equivalent contained in augmented bran, plus 178 thousand tons of whole wheat used in formula feed production, plus 6 thousand tons of other wheat feed use, add up to the total of 683 thousand tons of wheat feed use reported in the food balance sheet for 1979. Table 4.9 shows the author's estimated decomposition of the wheat feed totals reported in the Japanese food balance sheets.

Usually at least three-fourths, and sometimes more than nine-tenths, of the wheat "grain" feed reported in the food balance sheets is actually augmented bran! To limit the cost of subsidizing this bran, the government restricts the amount of wheat processed under the program. Thus the link between the price of wheat grain and the quantity of wheat used as feed is severed, for the dominant component of wheat feed.

Since the quantity of wheat feed has stayed within a range of about 550 to 700 thousand metric tons while the quantity of total grain feed has grown rapidly, the ratio of wheat feed to nonwheat feed has fallen over the long run. In the short run, deviations from trend of wheat feed use have tended to parallel deviations from trend of nonwheat feed use. 5/ This combination of short-term and long-term behavior underlies the good fit of the regression equation which predicts the ratio of wheat feed to nonwheat feed.

OTHER COARSE GRAINS FEED VERSUS RICE PLUS CORN FEED

A regression on the price ratio of sorghum to corn is used to divide nonwheat feed into other coarse grains feed and rice plus corn feed. Experiments with various equation specifications demonstrated that including a time trend is inappropriate. Regression equations run over 1965-79 poorly track the large fluctuations in the ratio of other coarse grain feed to rice plus corn feed between 1962 and 1970. However, the 1965-79 regressions do support the evidence from the 1972-79 regressions that the price ratio is a determinant of the feed ratio, whereas a time trend is not significant. (The evidence is set forth in Table 4.14.) The regression equation used in the model, estimated solely on the basis of data available from the food balance sheets, is:

$$
\begin{array}{llll}
\text{JPLFBORC} & = & -\ 0.267836 & -\ \ 1.951884\ \text{JPLPTSCN} \\
 & & \pm\ 0.036630 & \pm\ 0.796580 \\
 & & (7.312) & (2.450) \\
 & & 0.03\% & 4.98\%
\end{array}
$$

Adjusted R^2 = 41.69 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 1.075
Autocorrelation of residuals = 0.372

JPLFBORC = Japan, logarithm of ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

JPLPTSCN = Japan, logarithm of trade price ratio: (sorghum) / (corn), calendar year

The estimated price elasticity of 1.95 is high--a 1 percent increase in the ratio of the sorghum trade price to the corn trade price causes nearly a 2 percent decrease in the ratio of other coarse grains feed to rice plus corn feed. A high price elasticity does make sense in this context: first, since other coarse grains and corn are close substitutes as feed; and second, since the quantity ratio is kept within reasonable bounds by the fact that the trade price ratio fluctuates within a narrow band (largely because sorghum and corn are such close feed substitutes).

As in the previous section on wheat feed versus nonwheat feed, a series of identities transforms the estimated logarithm of the ratio into its constituent parts measured in thousand metric tons.

First:

JPQFBORC = EXP(JPLFBORC)

where:

EXP is the exponentiation (e^x) operator

JPQFBORC = Japan, ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

JPLFBORC = Japan, logarithm of ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

Then (with the variable JPQFCGFY rounded off to the nearest thousand metric tons):

JPQFCGFY = ROUND(JPQFNWFY * JPQFBORC / (1.0 + JPQFBORC))

where:

* indicates multiplication

ROUND(x) rounds off "x" to the nearest integer

JPQFCGFY = Japan, other coarse grains used as feed, fiscal year (thousand metric tons)

JPQFNWFY = Japan, nonwheat grains used as feed, fiscal year (thousand metric tons)

JPQFBORC = Japan, ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

Table 4.9--Estimated composition of wheat used as feed

Fiscal year	Normal milling rate (1)	Milling rate for augmented bran (2)	Difference between milling rates (3)	Wheat milled for augmented bran (4)	Reduction in flour output (5)	Wheat equivalent of reduction in flour output (6)	Whole wheat in formula feed (7)	Other feed use of wheat (8)	Total wheat used as feed (9)
	Ratio			Thousand metric tons					
1960	0.77	--	--	--	--	--	--	--	468
1961	0.76	--	--	--	--	--	76	--	616
1962	0.76	--	--	--	--	--	43	--	646
1963	0.76	--	--	--	--	--	38	--	520
1964	0.76	0.40	0.36	893	321.5	423	36	75	534
1965	0.77	0.40	0.37	893	330.4	429	21	80	530
1966	0.77	0.40	0.37	1001	370.4	481	17	45	543
1967	0.77	0.40	0.37	1101	407.4	529	18	45	592
1968	0.77	0.40	0.37	1130	418.1	543	17	7	567
1969	0.77	0.40	0.37	1130	418.1	543	43	81	667
1970	0.78	0.40	0.38	1131	429.8	551	140	10	701
1971	0.78	0.45	0.33	1131	373.2	478	125	29	632
1972	0.78	0.40	0.38	1151	437.4	561	132	14	707
1973	0.78	0.40	0.38	1181	448.8	575	122	11	708
1974	0.78	0.40	0.38	1182	449.2	576	45	-2 a/	619
1975	0.78	0.40	0.38	1180	448.4	575	15	0	590
1976	0.78	0.45	0.33	1180	389.4	499	58	19	576
1977	0.78	0.45	0.33	1180	389.4	499	132	6	637
1978	0.78	0.45	0.33	1180	389.4	499	163	7	669
1979	0.78	0.45	0.33	1180	389.4	499	178	6	683

Note:

a/ Statistical discrepancy; cause unknown.

Sources (by column):

(1) Japan, Ministry of Agriculture, Forestry and Fisheries (MAFF), Statistical Yearbook, food balance sheets, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions; and its revised Food Balance Sheets: 1955-1966. The data shown here come from the column titled "Extraction Rate".

(2) Author's estimates, based on sources cited in note 4 on page 100.

(3) Calculated as (3) = (1) - (2).

(4) Japan Feedstuff Association, Shiryo Geppo [Feed Monthly], pages 88-91 in the June 1981 edition and the equivalent table in earlier June issues.

(5) Calculated as (5) = (3) x (4).

(6) Calculated as (6) = (5) / (1), rounded to the nearest thousand metric tons.

(7) Japan, MAFF, Statistical Yearbook, formula feed tables, page 91 in the 1979/80 edition and the equivalent table in earlier editions.

(8) Calculated as (8) = (9) - (6) - (7).

(9) Japan, MAFF, food balance sheets, as in (1) above.

Finally:

JPQFRCFY = JPQFNWFY - JPQFCGFY

where:

JPQFRCFY = Japan, rice + corn used as feed, fiscal year (thousand metric tons)

JPQFNWFY = Japan, nonwheat grains used as feed, fiscal year (thousand metric tons)

JPQFCGFY = Japan, other coarse grains used as feed, fiscal year (thousand metric tons)

Figure 4.4 and Table 4.10 compare the estimated and actual values of other coarse grain feed. Figure 4.5 and Table 4.11 compare the estimated and actual values of rice plus corn feed. Despite the weak R^2 for the regression equation on the logarithm of the feed ratio, the estimates of feed quantities in thousand metric tons derived from that regression are usually within 5 percent of their correct value.

RICE FEED AND CORN FEED

The amount of rice feed depends on government policy. Here that policy is taken as a "given", so the amount of corn feed is calculated from the identity:

JPQFCNFY = JPQFRCFY - JPQFRIFY

where:

JPQFCNFY = Japan, corn used as feed, fiscal year (thousand metric tons)

JPQFRCFY = Japan, rice + corn used as feed, fiscal year (thousand metric tons)

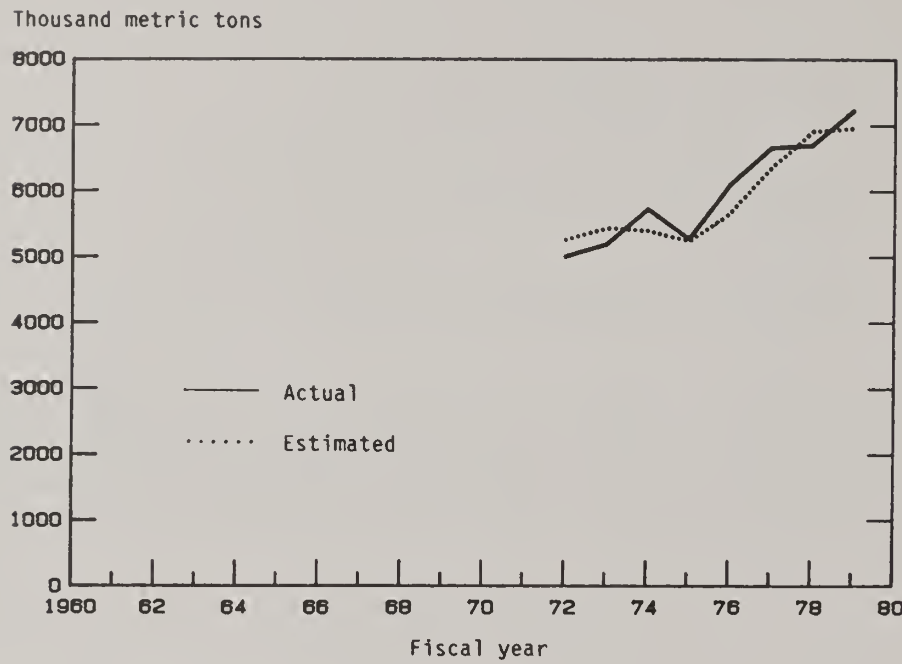
JPQFRIFY = Japan, rice used as feed, fiscal year (thousand metric tons, brown basis)

In these calculations, the actual amount of rice feed is subtracted from the estimated rice plus corn total derived from the series of equations shown above. Figure 4.6 and Table 4.12 compare the resultant estimates of corn feed use with the true values.

In Chapter Seven, rice feed will become an endogenous part of the model, and the rice plus corn feed total will be split anew.

Figure 4.4

Actual and Estimated Other Coarse Grain Used as Feed



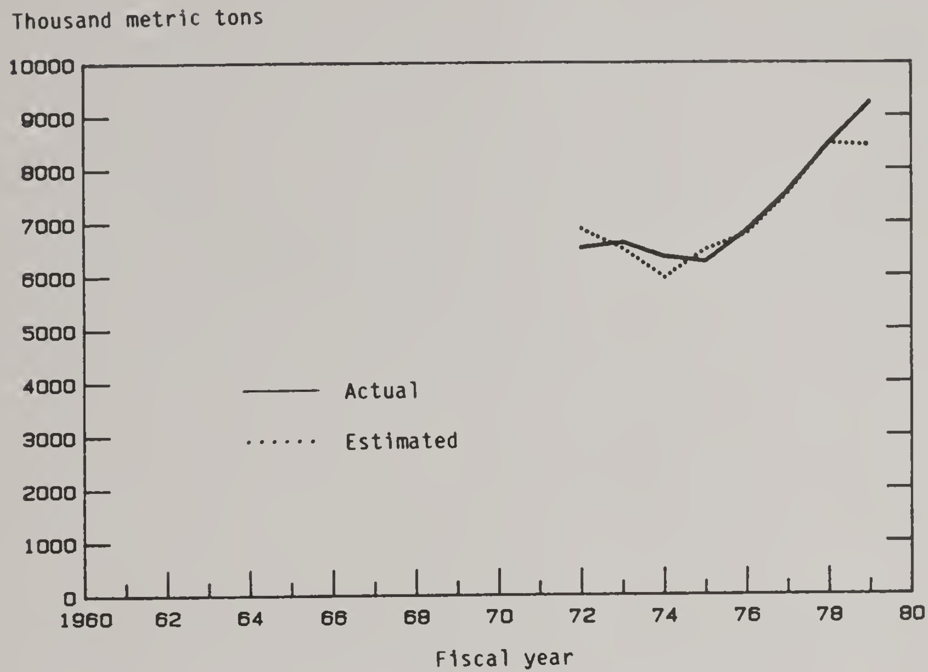
Source: Table 4.10

Table 4.10--Actual and estimated other coarse grains used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1972	5,011	5,272	-261	-5.2
1973	5,198	5,445	-247	-4.8
1974	5,736	5,407	329	5.7
1975	5,278	5,248	30	0.6
1976	6,104	5,674	430	7.0
1977	6,664	6,355	309	4.6
1978	6,701	6,911	-210	-3.1
1979	7,227	6,963	264	3.7
		Mean absolute value:	260	4.3
		Root mean square:	281	4.7

Sources: Table 4.1 and model estimates.

Figure 4.5
Actual and Estimated Rice Plus Corn Used as Feed



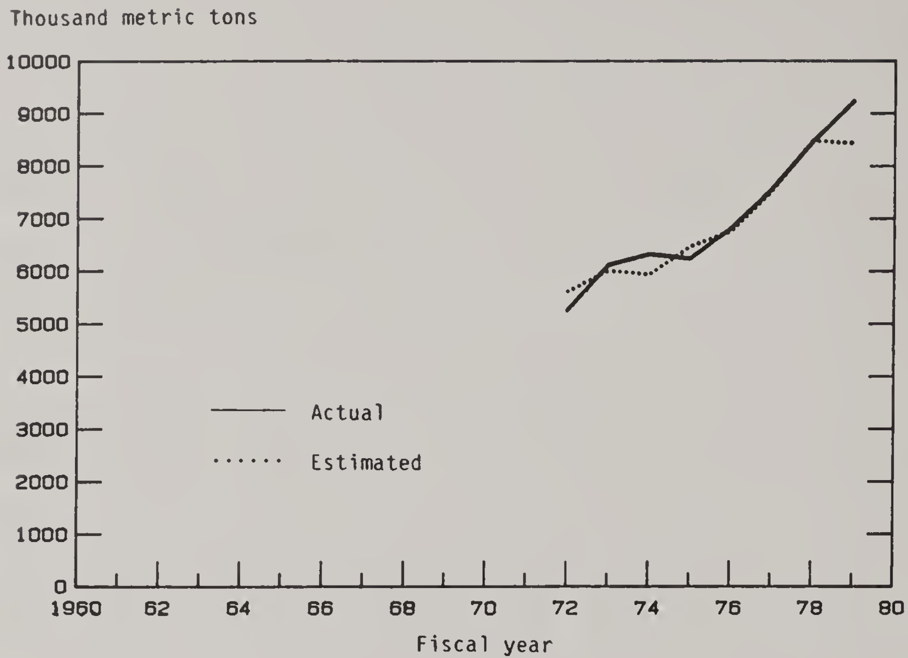
Source: Table 4.11

Table 4.11--Actual and estimated rice plus corn used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1972	6,541	6,892	-351	-5.4
1973	6,638	6,520	118	1.8
1974	6,362	5,974	388	6.1
1975	6,273	6,505	-232	-3.7
1976	6,853	6,801	52	0.8
1977	7,587	7,545	42	0.6
1978	8,494	8,505	-11	-0.1
1979	9,263	8,461	802	8.7
		Mean absolute value:	250	3.4
		Root mean square:	352	4.5

Sources: Table 4.1 and model estimates.

Figure 4.6
Actual and Estimated Corn Used as Feed



Source: Table 4.12

Table 4.12--Actual and estimated corn used as feed

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1972	5,276	5,627	-351	-6.7
1973	6,142	6,024	118	1.9
1974	6,349	5,961	388	6.1
1975	6,263	6,495	-232	-3.7
1976	6,841	6,789	52	0.8
1977	7,578	7,536	42	0.6
1978	8,486	8,497	-11	-0.1
1979	9,256	8,454	802	8.7
		Mean absolute value:	250	3.6
		Root mean square:	352	4.7

Sources: Table 4.1 and model estimates.

COMPENDIUM OF FEED DEMAND REGRESSION EQUATIONS

Because of its reduced-form nature, the feed demand block of the Japanese Grains Model provides less scope for policy analysis than the model's food demand block. Thus the alternative regression equations presented in this section serve mainly to document the reasons for the choice of model specification, rather than to provide alternative ways of analyzing policies.

Table 4.13 presents the set of regression specifications for total grain feed. Table 4.14 shows alternative logit regressions used to estimate the ratio of wheat feed to nonwheat feed. Table 4.15 presents the regressions for the ratio of other coarse grain feed to rice plus corn feed--in Part A based on data from 1972 to 1979, and in Part B based on data from 1965 to 1979. Feed is normally measured in thousand metric tons. The exceptions are the last equation in each of Table 4.13, Table 4.14, and Parts A and B of Table 4.15, where feed is measured in thousand metric tons of corn equivalent.

Table 4.13--Regression equations for total grain used as feed

Regression statistics	Intercept	ln(Income) JPLGNPFY	1/(Income) JP1GNPFY	ln(Price) JPLPTCO	Time trend YEAR	Comments
90.75% 0.653 .573	-106 ± 9 (11) 0.01%				0.056 ± .005 (12) 0.01%	
53.50% 0.569 .599	6.6 ± 0.5 (14) 0.01%			-0.69 ± .17 (4.1) 0.12%		
90.04% 0.653 .569	-102 ± 16 (6.6) 0.01%			-0.03 ± .12 (0.28) 78%	0.054 ± .008 (7.0) 0.01%	Insignificant price coefficient.
93.10% 0.640 .545	-3.0 ± 0.6 (5.5) 0.01%	1.17 ± 0.08 (14) 0.01%				
97.19% 1.481 .218	-52 ± 11 (4.7) 0.05%	0.68 ± 0.12 (5.6) 0.01%			0.026 ± .006 (4.5) 0.08%	
95.45% 1.421 .220	-1.4 ± 0.7 (1.9) 8.7%	1.00 ± 0.09 (11) 0.01%		-0.19 ± .07 (2.8) 1.7%		EQUATION USED IN MODEL.
97.36% 1.862 .038	-42 ± 13 (3.2) 0.83%	0.70 ± 0.12 (5.8) 0.01%		-0.08 ± 0.06 (1.3) 21%	0.021 ± .007 (3.1) 1.0%	Weak price coefficient.
96.06% 1.392 .195	-21 ± 5 (3.8) 0.24%	3.5 ± 0.7 (4.9) 0.04%	1,452 ± 443 (3.3) 0.66%			Wrong sign on income coefficients.
97.34% 1.739 .061	-48 ± 11 (4.2) 0.14%	1.8 ± 0.9 (2.1) 6.5%	625 ± 482 (1.3) 22%		0.020 ± .008 (2.6) 6.5%	Wrong sign on income coefficients.
96.93% 2.173 -.168	-15 ± 5 (2.8) 1.6%	2.8 ± 0.7 (4.0) 0.21%	1,105 ± 424 (2.6) 2.4%	-0.13 ± .06 (2.1) 6.0%		Wrong sign on income coefficients.
97.50% 2.245 -.185	-38 ± 13 (2.9) 1.6%	1.8 ± 0.9 (2.1) 6.4%	599 ± 468 (1.3) 23%	-0.08 ± .06 (1.3) 22%	0.015 ± .008 (1.9) 9.1%	Wrong sign on income coefficients; weak price coefficient.
95.46% 1.396 .229	-1.4 ± 0.7 (1.8) 9.4%	0.99 ± .09 (11) 0.01%		-0.20 ± .07 (2.8) 1.5%		Like equation in model, except feed in corn-equivalent tons.

(Continues to next page)

(Table 4.13, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQFTGF = Japan, logarithm of total grain used as feed, fiscal year (kilograms per capita)

Independent variables:

- JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)
- JP1GNPFY = Japan, 1/GNP, fiscal year (GNP in thousands of 1970 yen per capita)
- JPLPTCO = Japan, logarithm of trade price average, 60 percent corn plus 40 percent sorghum, calendar year (1970 yen per kilogram)
- YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 4.14--Regression equations for the ratio of wheat feed to nonwheat feed

Regression statistics	Intercept	ln(Trade price ratio) JPLPTWCO	ln(Resale price ratio) JPLPDWCO	Time trend YEAR	Comments
96.28% 2.433 -.260	119 ± 6 (19) 0.01%			-0.062 ± .003 (19) 0.01%	EQUATION USED IN MODEL.
4.24% 0.259 .750	-2.6 ± 0.2 (17) 0.01%	-0.9 ± 0.7 (1.3) 23%			Poor $\overline{R}^2$, weak price coefficient.
-3.54% 0.167 .763	-2.7 ± 0.2 (13) 0.01%		-0.3 ± 0.4 (0.72) 48%		Insignificant $\overline{R}^2$, poor price coefficient.
96.06% 2.484 -.281	121 ± 7 (17) 0.01%	0.08 ± .15 (0.54) 60%		-0.063 ± .004 (17) 0.01%	Wrong sign on price coefficient.
96.40% 2.672 -.361	121 ± 7 (19) 0.01%		0.08 ± .07 (1.2) 25%	-0.063 ± .003 (19) 0.01%	Wrong sign on price coefficient.
96.49% 2.502 -.291	120 ± 6 (19) 0.01%			-0.062 ± .003 (20) 0.01%	Like equation in model, except feed in corn-equivalent tons.

(Continues to next page)

(Table 4.14, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLQFWNW = Japan, logarithm of ratio: (wheat feed) / (nonwheat feed), fiscal year

Independent variables: JPLPTWCO = Japan, logarithm of ratio: (wheat trade price, calendar year) / (weighted average of corn and sorghum trade prices, calendar year)

JPLPDWCO = Japan, logarithm of ratio: (wheat resale price, fiscal year) / (weighted average of corn and sorghum trade prices, calendar year)

YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R^2}$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 4.15--Regression equations for the ratio of other coarse grains feed to rice plus corn feed

Part A: Based on data from 1972 through 1979

Regression statistics	Intercept	ln(Price ratio) JPLPTSCN	Time trend YEAR	Comments
-16.21% 1.287 .210	-4 $\pm$ 22 (0.16) 88%		0.002 $\pm$ .011 (0.15) 88%	Insignificant time coefficient and $\overline{R}^2$.
41.69% 1.075 .372	-0.27 $\pm$ .04 (7.3) 0.03%	-2.0 $\pm$ 0.8 (2.5) 5.0%		EQUATION USED IN MODEL. Weak $\overline{R}^2$.
30.09% 1.074 .379	1 $\pm$ 17 (0.05) 96%	-2.0 $\pm$ 0.9 (2.2) 7.6%	-.0006 $\pm$ .0087 (0.07) 95%	Insignificant time coefficient, weak $\overline{R}^2$.
38.85% 1.137 .327	-0.32 $\pm$ .04 (9.0) 0.01%	-1.8 $\pm$ 0.8 (2.3) 5.8%		Like equation in model, except feed in corn-equivalent tons.

Part B: Based on data from 1965 through 1979

Regression statistics	Intercept	ln(Price ratio) JPLPTSCN	Time trend YEAR	Comments
-0.41% 2.109 -.095	14 $\pm$ 14 (0.96) 35%		-0.007 $\pm$ .007 (0.97) 35%	Insignificant $\overline{R}^2$, poor time coefficient.
23.57% 1.846 -.048	-0.23 $\pm$ 0.04 (5.3) 0.02%	-1.3 $\pm$ 0.6 (2.3) 3.8%		Poor $\overline{R}^2$.
17.20% 1.843 -.046	-1 $\pm$ 15 (0.04) 97%	-1.3 $\pm$ 0.7 (1.9) 7.6%	0.0002 $\pm$ .0075 (0.03) 98%	Insignificant time coefficient, poor $\overline{R}^2$.
21.84% 1.812 -.033	-0.28 $\pm$ .04 (6.5) 0.01%	-1.2 $\pm$ 0.6 (2.2) 4.5%		Like second equation above, except feed in corn-equivalent tons.

(Continues to next page)

(Table 4.15, continued)

The regressions were run over an 8-year interval (in Part A), or over a 15-year interval (in Part B).

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLFBORC = Japan, logarithm of ratio: (barley + other grain feed) / (rice + corn feed), fiscal year

Independent variables: JPLPTSCN = Japan, logarithm of trade price ratio: (sorghum) / (corn), calendar year

YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

1/ The complete formula feed tables appear in the Japanese-language publication Shiryo Geppo [Feed Monthly], published by the Japanese Feedstuff Association using data provided by the Ministry of Agriculture, Forestry and Fisheries. A fiscal-year summary is printed in each June issue (pages 44-49 in the June 1981 issue, for example). The annual data has been compiled by William T. Coyle in Japan's Feed-Livestock Economy: Prospects for the 1980's (Foreign Agricultural Economic Report 177, Economic Research Service, U.S. Dept. of Agriculture, February 1983) as Appendix Tables 4-8. A less complete version of the formula feed tables is printed in the MAFF Statistical Yearbook (page 91 in the 1979-80 edition, for example).

2/ Regressions which combine rice with corn are well-behaved; whereas regressions which combine rice with other coarse grains are ill-behaved, both in terms of overall R^2 and in terms of individual t-statistics.

3/ The equation is derived as follows. By definition:

(Wheat feed) / (Nonwheat feed) = JPQFWNWF

(Wheat feed) / (Total feed - Wheat feed) = JPQFWNWF

Then:

(Wheat feed) = (Total feed - Wheat feed) * (JPQFWNWF)

(Wheat feed) = (Total feed) * (JPQFWNWF) - (Wheat feed) * (JPQFWNWF)

(Wheat feed) + (Wheat feed) * (JPQFWNWF) = (Total feed) * (JPQFWNWF)

(Wheat feed) * (1 + JPQFWNWF) = (Total feed) * (JPQFWNWF)

(Wheat feed) = (Total feed) * (JPQFWNWF) / (1 + JPQFWNWF)

4/ This program is called "Senkan" or "Zosan" depending on the kind of mill producing the special bran. This author found detailed descriptions of the program only in two obscure documents: The Japan Flour Millers Association, Japanese Wheat Import and Pricing Policies (unpublished working paper, Economics, Statistics, and Cooperatives Service, U.S. Dept. of Agriculture, May 1978), pages 27, 31, 34, and 64-67; and Wheat Associates, U.S.A., Wheat Importation and Marketing in Japan (Tokyo: "study... published by the National Food Life Improvement Association under contract with Wheat Associates, U.S.A., in cooperation with the Food Agency, Ministry of Agriculture and Forestry, the Foreign Agricultural Service, United States Department of Agriculture, and the Japan Flour Milling Industry Development Foundation," 1971), pages 194-203.

5/ When wheat feed and nonwheat feed are both regressed on time over the span 1965-79, and the residuals from the wheat equation are then regressed on the residuals from the nonwheat equation, the adjusted R^2 is 45 percent. (The unadjusted correlation between the residuals is 49 percent.) For every thousand metric tons by which nonwheat feed usage exceeds trend, wheat feed usage is expected to be 0.06 thousand metric tons above its trend. With a standard error of 0.02, this coefficient is significant at the 1 percent level.

CHAPTER FIVE

CROPS

SUMMARY

Modeling Approach

The crops component of the Japanese Grains Model calculates production net of seed use. For the major grain crops--rice, wheat, and barley--yield is estimated; then area is estimated; production follows from its identity to yield times area; and finally an allowance for seed is subtracted. For minor grain crops--corn and other grain--production net of seed use is estimated in a single step. Most of the explanatory variables used in crop sector equations are only approximations (proxies) to the true causes; sometimes they are very crude approximations. Despite this, the accuracy of the estimations is quite satisfactory.

For a schematic outline of the crops component, see Figure 5.1 (page 111).

Definitions of Explanatory Variables

In this model, farmers are assumed to base their decisions on expected gross revenue per hectare, defined as last year's government-set supply price times the average of the last 3 years' yields. Thus for rice, wheat, and barley:

Identities:

[26] JPXRRIR = LAG1(JPPSRIR) *
(LAG1(JPYDRI) + LAG2(JPYDRI) + LAG3(JPYDRI)) / 3

[27] JPXRWHR = LAG1(JPPSWHR) *
(LAG1(JPYDWH) + LAG2(JPYDWH) + LAG3(JPYDWH)) / 3

[28] JPXRBAR = LAG1(JPPSBAR) *
(LAG1(JPYDBA) + LAG2(JPYDBA) + LAG3(JPYDBA)) / 3

where:

* indicates multiplication

LAGn(x) is the value of "x" lagged by "n" years

and where:

JPXRaaR = Japan, expected revenue from aa
(thousands of 1970 yen per hectare);
with aa from the list:

RI = rice
WH = wheat
BA = barley

JPPSaaR = Japan, supply price for aa (1970 yen per kilogram); with aa defined as above.

JPYDaa = Japan, yield for aa (metric tons per hectare); with aa defined as above.

To determine the average expected revenue across several crops, the previous year's areas are used as weights (lagging the areas greatly simplifies the calculations without reducing the accuracy of the predictions obtained). Thus:

Identities:

[29] JPXRWBR = (JPXRWHR * LAG1(JPHAWH) + JPXRBAR * LAG1(JPHABA)) / (LAG1(JPHAWH) + LAG1(JPHABA))

[30] JPXRTGR = (JPXRRIR * LAG1(JPHARI) + JPXRWHR * LAG1(JPHAWH) + JPXRBAR * LAG1(JPHABA)) / (LAG1(JPHARI) + LAG1(JPHAWH) + LAG1(JPHABA))

where:

JPXRWBR = Japan, average expected revenue from wheat and barley (thousands of 1970 yen per hectare)

JPXRTGR = Japan, average expected revenue from grains (thousands of 1970 yen per hectare)

JPHARI = Japan, rice area planted (thousand hectares)

JPHAWH = Japan, wheat area planted (thousand hectares)

JPHABA = Japan, barley area planted (thousand hectares)

For use in regression equations, expected revenue variables are transformed into logarithmic terms:

Identities:

[31] JPLXRRI = LOG(JPXRRIR)

[32] JPLXRWH = LOG(JPXRWHR)

[33] JPLXRBA = LOG(JPXRBAR)

[34] JPLXRWB = LOG(JPXRWBR)

[35] JPLXRTG = LOG(JPXRTGR)

[36] JPLRWHBA = LOG(JPXRWHR / JPXRBAR)

where:

LOG is the natural logarithm operator

and where:

JPLXRaa = Japan, logarithm of expected revenue from aa (thousands of 1970 yen per hectare); with aa from the list:

RI = rice
WH = wheat
BA = barley
WB = wheat and barley
TG = grains (rice, wheat, and barley)

JPXRaaR = Japan, expected revenue from aa (thousands of 1970 yen per hectare); with aa defined as above.

JPLRWHBA = Japan, logarithm of ratio: (wheat expected revenue) / (barley expected revenue)

To obtain a variable whose units of measurement are comparable to variables expressed in terms of the logarithm of thousands of 1970 yen per hectare, the rice diversion payment is transformed into a "log-ratio" as follows: 1/

Identity:

[37] JPLXRDP = LOG((JPXRRIR - JPDPRIR) / JPXRRIR)

where:

JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)

JPXRRIR = Japan, rice expected revenue (thousands of 1970 yen per hectare)

JPDPRIR = Japan, rice diversion payment (thousands of 1970 yen per hectare)

Here the diversion payment is treated as an opportunity cost for growing rice. When the diversion payment (JPDPRIR) is zero, its log-ratio measure (JPLXRDP) also equals zero. The greater the premium for not growing rice, relative to the expected revenue from growing rice, the more negative is the value of JPLXRDP. The diversion payment variable is not lagged, since the Japanese government announces its (nominal) level several years in advance.

It may be noted that the diversion payment variable never played a significant enough role to be included in a regression equation selected for the model. However, JPLXRDP does appear in the compendium of regression equations at the end of this chapter.

Yields

For rice, yield is modeled as a time trend (representing the effects of technical progress); for wheat and barley, yield is modeled as a function of lagged price. Estimated yields are rounded off to the nearest 0.01 metric ton per hectare.

Behavioral Equations:

[38] JPLYDRI = - 24.684246 + 0.013270 * YEAR

[39] JPLYDWH = - 2.932346 + 0.959714 * LAG1(JPLPSWH)

[40] JPLYDBA = - 1.458046 + 0.635784 * LAG1(JPLPSBA)

Identities:

[41] JPYDRI = ROUND(EXP(JPLYDRI), 0.01)

[42] JPYDWH = ROUND(EXP(JPLYDWH), 0.01)

[43] JPYDBA = ROUND(EXP(JPLYDBA), 0.01)

where:

EXP is the exponentiation (e^x) operator

ROUND(x,0.01) rounds off "x" to the nearest hundredth of an integer

LAG1(x) is the value of "x" lagged by 1 year

and where:

JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)

JPLYDWH = Japan, logarithm of wheat yield (metric tons per hectare)

JPLYDBA = Japan, logarithm of barley yield (metric tons per hectare)

JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

JPLPSBA = Japan, logarithm of barley supply price (1970 yen per kilogram)

YEAR = Japanese fiscal year (values from 1965 to 1979)

Areas

The model's crop sector first estimates the total area planted, then allocates it among individual crops, following a "nested logit" approach quite similar to that used in Chapter Four to calculate total feed, then allocate it among individual feedgrains. The sequence of area divisions and subdivisions appears to parallel the process of Japanese policy making, as will become more evident in Chapter Seven. Farming--especially for labor-intensive crops--is

in competition with off-farm employment. In this model, lagged real GNP per capita is used as an admittedly crude proxy for expected revenue from off-farm employment. In the equation predicting the total area planted, population serves as a proxy for the pressures of urbanization on farmland. Estimated areas are rounded off to the same precision as the data on their actual values.

Behavioral Equations:

```
[44]  JPLHATG   =  16.467461  +  0.181713 * JPLXRTG  -  0.551044 * JPLPOPFY
                   -  0.383614 * LAG1(JPLGNPFY)

[45]  JPLHRINR  =  - 4.181643  +  0.896910 * JPLXRRI  -  0.339649 * JPLXRWB

[46]  JPLHWBON  =  8.815184  +  1.457413 * JPLXRWB  -  2.819321 * LAG1(JPLGNPFY)

[47]  JPLHWHBA  =  - 0.053372  +  2.218002 * JPLRWHBA
```

Identities:

```
[48]  JPHATG    =  ROUND( EXP(JPLHATG) )

[49]  JPHARINR  =  EXP(JPLHRINR)

[50]  JPHARI    =  ROUND( JPHATG * JPHARINR / (1.0 + JPHARINR) )

[51]  JPHANR    =  JPHATG - JPHARI

[52]  JPHAWBON  =  EXP(JPLHWBON)

[53]  JPHAWB    =  ROUND( JPHANR * JPHAWBON / (1.0 + JPHAWBON),  0.1 )

[54]  JPHAON    =  ROUND( JPHANR - JPHAWB )

[55]  JPHAWHBA  =  EXP(JPLHWHBA)

[56]  JPHAWH    =  ROUND( JPHAWB * JPHAWHBA / (1.0 + JPHAWHBA),  0.1 )

[57]  JPHABA    =  JPHAWB - JPHAWH
```

where:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

ROUND(x,0.1) rounds off "x" to the nearest tenth of an integer

LAG1(x) is the value of "x" lagged by 1 year

and where:

JPLHATG = Japan, logarithm of gross area planted to all crops (thousand hectares)

JPLHxxyy = Japan, logarithm of ratio: xxyy; with xxyy from the list:

RINR = (rice area) / (nonrice area)
WBON = (wheat plus barley area) / (other nonrice area)
WHBA = (wheat area) / (barley area)

JPHAxxyy = Japan, ratio: xxyy; with xxyy defined as above.

JPHAaa = Japan, area planted to aa (thousand hectares); with aa from the list:

TG = all crops (includes nongrain crops)
RI = rice
NR = nonrice crops
WB = wheat and barley
ON = other nonrice crops (excludes wheat and barley)
WH = wheat
BA = barley

JPLXRaa = Japan, logarithm of expected revenue from aa (thousands of 1970 yen per hectare); with aa defined as above.

JPLPOPFY = Japan, logarithm of population on October 1 (thousands)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

JPLRWHBA = Japan, logarithm of ratio: (wheat expected revenue) / (barley expected revenue)

Quantities Supplied

For rice, wheat, and barley, production is calculated from its identity to yield times area, with the product rounded off to the nearest thousand metric tons.

Identities:

[58] JPQSRIFY = ROUND(JPYDRI * JPHARI)

[59] JPQSWHFY = ROUND(JPYDWH * JPHAWH)

[60] JPQSBAFY = ROUND(JPYDBA * JPHABA)

where:

ROUND(x) rounds off "x" to the nearest integer

JPQSaaFY = Japan, quantity supplied of aa, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley

JPYDaa = Japan, yield for aa (metric tons per hectare); with aa defined as above.

JPHAaa = Japan, area planted to aa (thousand hectares); with aa defined as above.

Seed Used

Seed usage is estimated very simply as a constant fraction of production, with the estimates taken to the nearest thousand metric tons.

Behavioral Equations:

[61] JPQZRIFY = ROUND(0.0075 * JPQSRIFY)

[62] JPQZWHFY = ROUND(0.04 * JPQSWHFY)

[63] JPQZBAFY = ROUND(0.025 * JPQSBAFY)

where:

ROUND(x) rounds off "x" to the nearest integer

JPQZaaFY = Japan, quantity of aa used as seed, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley

JPQSaaFY = Japan, quantity supplied of aa, fiscal year (thousand metric tons); with aa defined as above.

Production Net of Seed Used

For rice, wheat, and barley, production net of seed use is determined by an accounting identity.

Identities:

[64] JPQPRIFY = JPQSRIFY - JPQZRIFY

[65] JPQPWHFY = JPQSWHFY - JPQZWHFY

[66] JPQPBAFY = JPQSBAFY - JPQZBAFY

<u>where</u>:

JPQPaaFY = Japan, production of aa net of seed used, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley

JPQSaaFY = Japan, quantity supplied of aa, fiscal year (thousand metric tons); with aa defined as above.

JPQZaaFY = Japan, quantity of aa used as seed, fiscal year (thousand metric tons); with aa defined as above.

For corn and for other grain, production net of seed use is estimated directly, as a time trend.

<u>Behavioral Equations</u>:

[67] JPLQPCNF = 472.577 - 0.238086 * YEAR

[68] JPLQPOGF = 232.147 - 0.115527 * YEAR

<u>Identities</u>:

[69] JPQPCNFY = ROUND(EXP(JPLQPCNF))

[70] JPQPOGFY = ROUND(EXP(JPLQPOGF))

<u>where</u>:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

<u>and where</u>:

JPLQPCNF = Japan, logarithm of corn production net of seed used, fiscal year (thousand metric tons)

JPLQPOGF = Japan, logarithm of other grain production net of seed used, fiscal year (thousand metric tons)

JPQPCNFY = Japan, corn production net of seed used, fiscal year (thousand metric tons)

JPQPOGFY = Japan, other grain production net of seed used, fiscal year (thousand metric tons)

YEAR = Japanese fiscal year (values from 1972 to 1979)

Finally, other coarse grain production net of seed used is equal by definition to barley net production plus other grain net production:

Identity:

[71] JPQPCGFY = JPQPBAFY + JPQPOGFY

where:

JPQPaaFY = Japan, production of aa net of seed used, fiscal year (thousand metric tons); with aa from the list:

CG = other coarse grains
BA = barley
OG = other grain

REVIEW OF DATA

This chapter encompasses production and seed use. Table 5.1 brings together production and seed data. Other variables appearing in this chapter already have been presented in Table 2.7 (areas and yields), Table 2.15 (supply prices), Table 2.17 (population), and Table 2.18 (gross national product).

Particularly severe weather in 1963 greatly reduced wheat and barley harvests. Hence in graphs for these two crops, the value for 1963 often appears as an outlier.

MODELING APPROACH FOR CROPS

Because corn and "other grain" production is very small and declining, these two crops are treated in summary fashion: production net of seed use is modeled as a time trend. For rice, wheat, and barley, the calculations are more detailed. First, yield estimates are obtained from regression equations. Next the total area planted to all crops is estimated; then this total is subdivided among rice, wheat, barley, and "other nonrice" areas. Production estimates follow from the identity that predicted production equals predicted yield times predicted area. Finally, seed use, modeled as a constant fraction of production, is subtracted from it to obtain estimated production net of seed.

The crops sector of the Japanese Grains Model is more complex than the food and feed sectors, primarily because certain variables depend upon the values of other variables in previous years. Figure 5.1 shows the relationships between the categories of variables in the crops sector, as pertains for rice, wheat, and barley. (For corn and for other grain, the flow chart collapses to one dotted arrow joining the TIME TREND box to the PRODUCTION NET OF SEED USED box.) Most of the boxes in the flow chart represent a group of variables--for example, the YIELDS box includes rice yield, wheat yield, and barley yield. The contents of Figure 5.1 are explained over the course of this chapter.

To avert confusion later, some terminology should be clarified now.

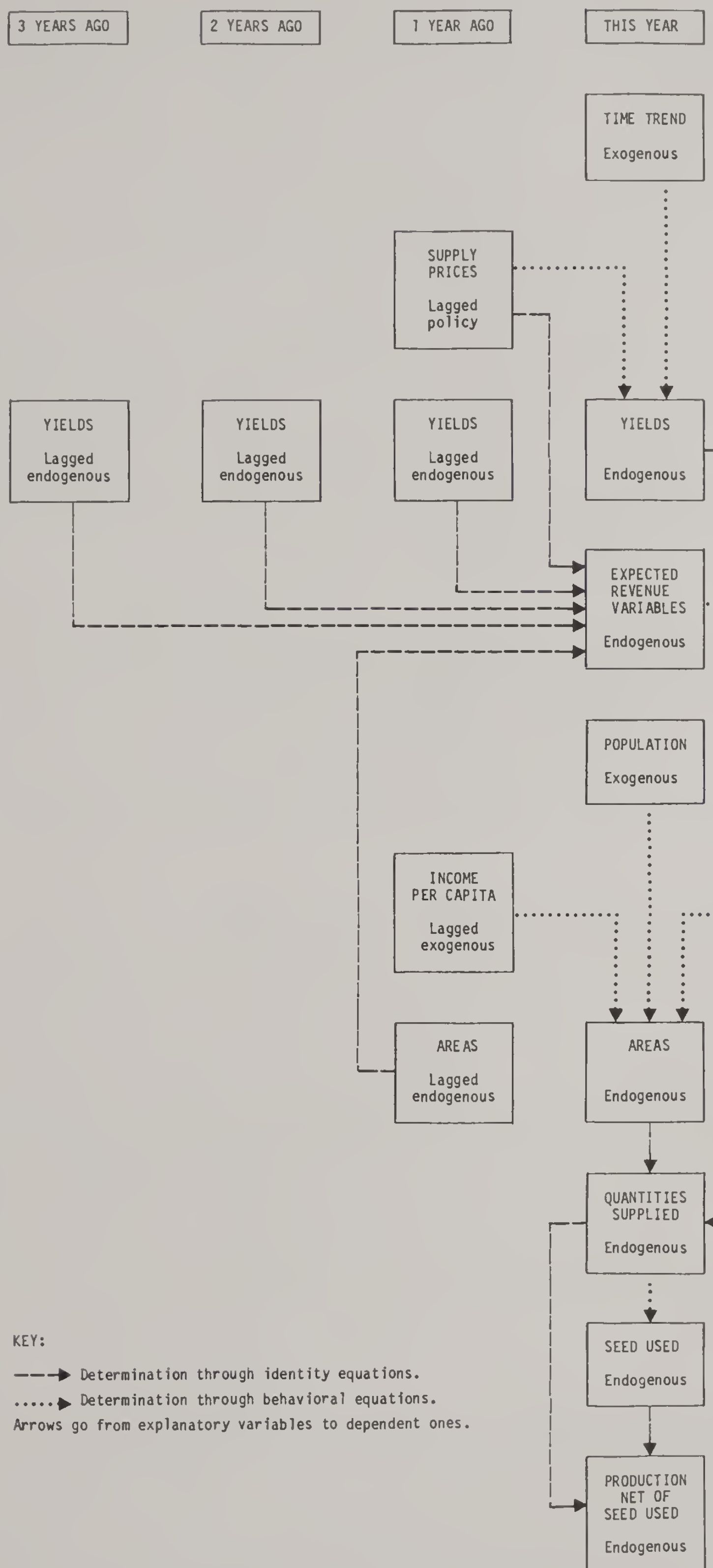
Table 5.1--Grain production and seed use

Fiscal year	Rice		Wheat		Barley		Corn		Other grain	
	Quantity supplied	Used as seed	Quantity supplied	Used as seed	Quantity supplied	Used as seed	Quantity supplied	Used as seed	Quantity supplied	Used as seed
	Thousand metric tons									
1960	12,858	104	1,531	40	2,301	42	--	--	--	--
1961	12,419	101	1,781	43	1,976	37	--	--	--	--
1962	13,009	98	1,631	38	1,726	35	--	--	--	--
1963	12,812	101	716	31	759	27	--	--	--	--
1964	12,584	101	1,244	27	1,202	23	--	--	--	--
1965	12,409	101	1,287	26	1,234	20	--	--	--	--
1966	12,745	103	1,024	22	1,105	19	--	--	--	--
1967	14,453	103	997	24	1,032	22	--	--	--	--
1968	14,449	104	1,012	22	1,021	18	--	--	--	--
1969	14,003	105	758	17	812	14	--	--	--	--
1970	12,689	99	474	11	573	10	--	--	--	--
1971	10,887	93	440	9	503	8	--	--	--	--
1972	11,889	94	284	6	324	5	23	0	85	3
1973	12,149	91	202	5	216	5	17	2	74	3
1974	12,292	93	232	8	233	5	14	2	67	2
1975	13,165	96	241	9	221	6	14	2	52	5
1976	11,772	98	222	8	210	5	12	2	39	2
1977	13,095	97	236	10	206	5	8	2	40	1
1978	12,589	92	367	14	326	8	7	2	47	1
1979	11,958	90	541	21	407	11	5	1	38	2

Note: The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Taken from Tables 2.1 through 2.5, which in turn are based on Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions, and its revised Food Balance Sheets: 1955-1966.

Figure 5.1--Block Structure of Crops Sector



This model contains three kinds of variables. "Endogenous" variables are those whose values are determined by the model itself--for example, areas and yields. "Exogenous" variables are those whose values are determined outside the model (in other words, their value is in each case taken as a "given"). They include population, gross national product, and the world trade prices for grains. "Policy" variables fall between endogenous and exogenous variables. Through Chapter Six, their values are taken as "givens", so they are treated like exogenous variables. In Chapters Seven and Eight, the values of the policy variables are determined by the model itself, so they become in effect endogenous variables. This model's policy variables are the supply prices of rice, wheat, and barley; the rice diversion payment; and the quantities of rice used as feed or exported.

In this report, "estimates" or "estimations" refer to values for endogenous variables calculated on the basis of the true levels of policy variables. "Simulations," on the other hand, refer to values for endogenous variables calculated on the basis of the calculated levels of policy variables. For estimations, the values of policy variables are given (perfectly) from outside the model; for simulations, the values of policy variables are determined (imperfectly) by the model itself.

A similar distinction separates "static" from "dynamic". Static estimation is based on the true values of lagged endogenous variables (as well as the true values of policy and exogenous variables). Dynamic estimation is based on the calculated values of lagged endogenous variables (but the true values of policy variables and exogenous variables). 2/

A simplified example may clarify these concepts. Suppose two equations predict that:

(Rice yield) = 2.75 + 0.01 (Year - 1964)

(Rice area) = 50 + 0.4 (Rice price last year) (Rice yield last year)

A static estimation of the rice area this year would be obtained by substituting the true values of rice price and yield last year into the second equation. A dynamic estimation of the rice area this year would be obtained by substituting the true value of the rice price last year, and the calculated value of the rice yield last year (obtained from the first equation), into the second equation. Finally, a dynamic simulation of the rice area this year would be obtained by substituting the calculated value of the rice price last year (obtained from a policy equation in Chapter Seven), and the calculated value of the rice yield last year (obtained from the first equation), into the second equation.

In general, static estimation isolates one behavioral equation from the rest of the model. (Sometimes--notably for areas--static estimation isolates one set of related behavioral equations from the rest of the model.) If the static estimates have large errors, the problem lies in that equation (or set of related equations). At the other extreme, dynamic simulation shows how well a behavioral equation performs in the context of the entire model. And dynamic estimation shows how well a behavioral equation performs in the context of the model excluding those equations which predict policies. (The model without its policy component can be used to analyze questions concerning

the difference it would have made in the past if the Japanese government had implemented other policies.)

Every regression equation in this model has been estimated on the basis of the actual values of all variables. In previous chapters, no lagged variable has appeared in any equation, so that static estimates have been indistinguishable from dynamic estimates.

YIELDS

Modeling Approach for Yields

Yield can be modeled as a function of time (representing technical progress), price, the rice diversion payment, and area.

The coefficient for time, of course, should be positive.

That for price probably should be positive: a higher price makes it profitable to use more fertilizer, labor, and other variable inputs, thereby increasing yield. On the other hand, a higher price may encourage production to spread to lower quality land, thereby reducing yield. Also, a high yield could flood the market and reduce price; but in Japan this reverse mechanism is avoided (at least in the short run), because supply prices are maintained by the government.

A high rice diversion payment will cause farmers to cease growing rice on their least productive paddy land, so the average rice yield should go up. At the same time, the diverted paddy land should help increase the average yields of the substitute crops to which it is planted.

In a regression of yield on area alone, the area coefficient may be positive or negative. A larger area could be associated with a lower yield (for example, when cultivation is extended to land of marginal quality). But a larger area also could be associated with a higher yield (for example, when higher yields stemming from technical progress cause an expansion of the area planted). Therefore it makes little sense to estimate an area coefficient unless the regression equation controls for the influences of price and technology--in which case the area coefficient should be negative. Even so, the omission or the misspecification of relevant variables may lead to a falsely positive area coefficient.

In practice, the yield regressions assayed for the model were all variants of the form:

$$\begin{aligned}\mathrm{LOG(Yield)} = {} & a + b\ \mathrm{LOG(Area)} + c\ \mathrm{LOG(Price)} + \\ & d\ (\text{Log-ratio measure of rice diversion payment}) + \\ & e\ (\mathrm{Year})\end{aligned}$$

Also in practice, no regression equation including an area variable or a diversion payment variable proved to be acceptable. Thus the model simply treats yield as a function of price or of time.

Rice Yield

A time trend gives the best predictions for rice yields:

$$\begin{array}{llll} \text{JPLYDRI} = & -\ 24.684246 & + & 0.013270\ \text{YEAR} \\ & \pm\ 5.745836 & \pm & 0.002914 \\ & (4.296) & & (4.554) \\ & 0.09\% & & 0.05\% \end{array}$$

Adjusted R^2 = 58.51 percent for 15 observations (JFY 1965-69)
Durbin-Watson statistic = 2.053
Autocorrelation of residuals = -0.076

JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)

YEAR = Japanese fiscal year (values from 1965 to 1979)

When the regression results are converted into estimated yields, the values are rounded off to the nearest 0.01 metric ton per hectare, matching the precision of the yield data in MAFF's Statistical Yearbook. Thus:

JPYDRI = ROUND(EXP(JPLYDRI), 0.01)

where:

EXP is the exponentiation (e^x) operator

ROUND(x,0.01) rounds off "x" to the nearest hundredth of an integer

JPYDRI = Japan, rice yield (metric tons per hectare, brown basis)

JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)

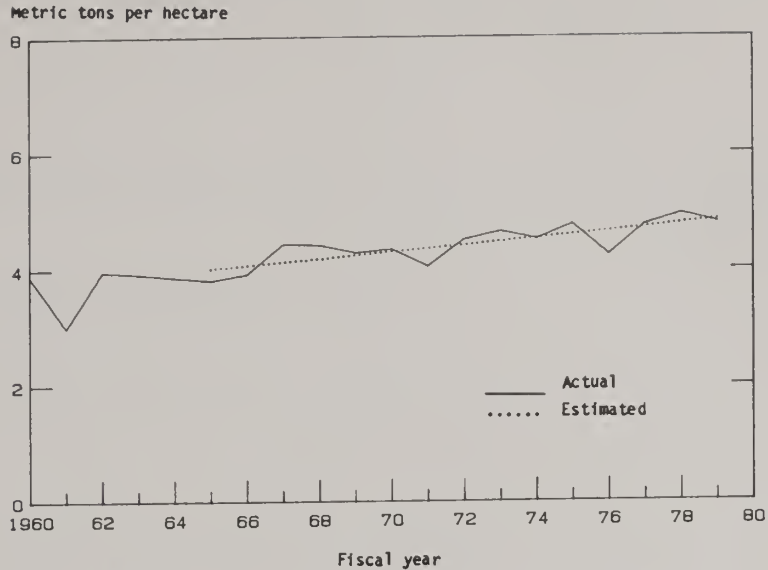
Actual and estimated values are compared in Figure 5.2 and Table 5.2.

Wheat Yield

For wheat, the most reliable results are obtained from a regression on price alone. Across many variants of the regression equation, lagged price is a better predictor than current price--presumably because farmers have made most of their production decisions by the time the government announces the official supply price.

Figure 5.2

Actual and Estimated Rice Yield in Japan



Source: Table 5.2

Table 5.2--Actual and estimated rice yield

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	- Metric tons per hectare -			Percent
1960	3.89	--	--	--
1961	3.76	--	--	--
1962	3.96	--	--	--
1963	3.92	--	--	--
1964	3.86	--	--	--
1965	3.81	4.02	-0.21	-5.5
1966	3.92	4.07	-0.15	-3.8
1967	4.43	4.13	0.30	6.8
1968	4.41	4.18	0.23	5.2
1969	4.28	4.24	0.04	0.9
1970	4.34	4.30	0.04	0.9
1971	4.04	4.35	-0.31	-7.7
1972	4.50	4.41	0.09	2.0
1973	4.64	4.47	0.17	3.7
1974	4.51	4.53	-0.02	-0.4
1975	4.76	4.59	0.17	3.6
1976	4.24	4.65	-0.41	-9.7
1977	4.75	4.71	0.04	0.8
1978	4.94	4.78	0.16	3.2
1979	4.79	4.84	-0.05	-1.0
		Mean absolute value:	0.16	3.7
		Root mean square:	0.20	4.6

Note: Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 2.7 and model estimates.

The equation used to estimate the wheat yield is:

$$JPLYDWH = \underset{\pm\ 1.010708}{-\ 2.932346} + \underset{\pm\ 0.246480}{0.959714}\ LAG1(JPLPSWH)$$

$$\begin{array}{ll} (2.901) & (3.894) \\ 1.24\% & 0.18\% \end{array}$$

Adjusted R^2 = 50.29 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 2.146
Autocorrelation of residuals = -0.090

JPLYDWH = Japan, logarithm of wheat yield (metric tons per hectare)

JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

LAG1(x) = value of "x" lagged by 1 year

Again, estimated yields are rounded off to the nearest 0.01 metric ton per hectare:

JPYDWH = ROUND(EXP(JPLYDWH), 0.01)

where:

EXP is the exponentiation (e^x) operator

ROUND(x,0.01) rounds off "x" to the nearest hundredth of an integer

JPYDWH = Japan, wheat yield (metric tons per hectare)

JPLYDWH = Japan, logarithm of wheat yield (metric tons per hectare)

Figure 5.3 and Table 5.3 compare actual and estimated wheat yields. Because price is a policy variable (not treated like an endogenous variable), here there is no difference between static and dynamic estimates.

Barley Yield

For barley (like wheat) the most reliable results are obtained from a regression on lagged price alone:

$$JPLYDBA = \underset{\pm\ 0.610521}{-\ 1.458046} + \underset{\pm\ 0.153636}{0.635784}\ LAG1(JPLPSBA)$$

$$\begin{array}{ll} (2.388) & (4.138) \\ 3.28\% & 0.12\% \end{array}$$

Adjusted R^2 = 53.53 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 2.296
Autocorrelation of residuals = -0.155

JPLYDBA = Japan, logarithm of barley yield (metric tons per hectare)

JPLPSBA = Japan, logarithm of barley supply price (1970 yen per kilogram)

LAG1(x) = value of "x" lagged by 1 year

Once again, estimated yields are rounded to the nearest 0.01 metric ton per hectare:

JPYDBA = ROUND(EXP(JPLYDBA), 0.01)

where:

EXP is the exponentiation (e^x) operator

ROUND(x,0.01) rounds off "x" to the nearest hundredth of an integer

JPYDBA = Japan, barley yield (metric tons per hectare)

JPLYDBA = Japan, logarithm of barley yield (metric tons per hectare)

Figure 5.4 and Table 5.4 compare actual and estimated barley yields.

AREAS

Special Explanatory Variables for Areas

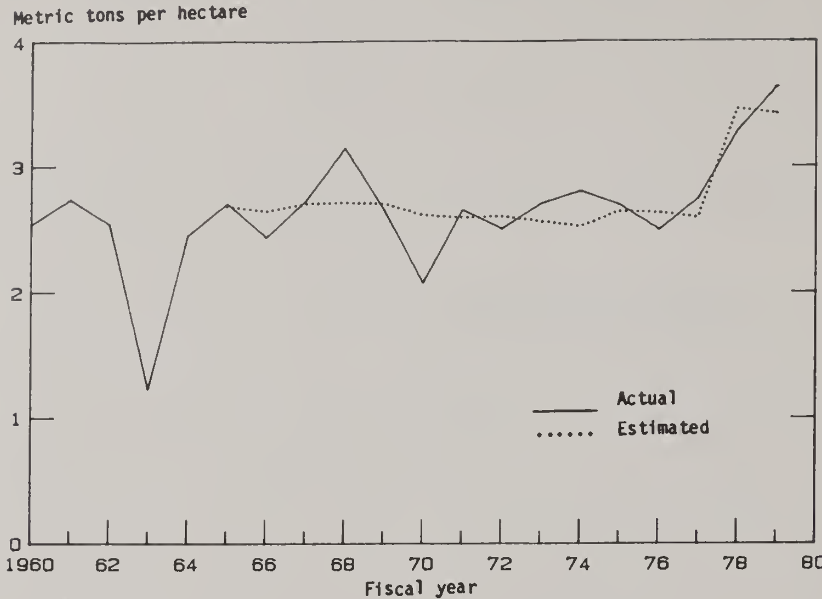
Several of the variables used to explain area are complex transformations of data introduced in Chapter Two. The following sections explain the derivation of variables representing the revenue landowners could expect to receive from growing crops, the revenue they could expect to receive from off-farm employment, and the revenue they could expect to receive from not growing rice on land eligible for the rice diversion payment.

Expected Revenue from Crops

The Japanese government sets official supply prices for standard grades of rice, wheat, and barley (among other crops); the Japanese Food Agency, which purchases grains at these prices, dominates the market but does not monopolize it. (Grains sold to the private sector outside of the Food Agency framework are usually of above standard grade and fetch a premium price.) However, the supply price is announced after most crops have been planted, so that the supply price for the previous year's harvest is the most recent information available when farmers allocate their lands.

Farmers' decisions depend not only upon the price they expect to receive, but also upon the yield they expect to obtain. In this model, farmers' expected revenue per hectare is defined as last year's official supply price times the average of the past 3 years' yields:

Figure 5.3
Actual and Estimated Wheat Yield in Japan



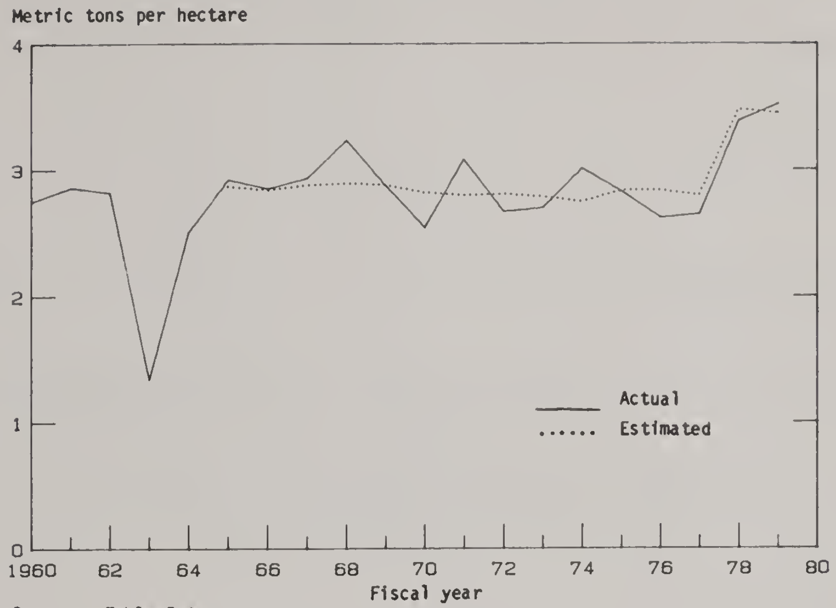
Source: Table 5.3

Table 5.3--Actual and estimated wheat yield

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	- Metric tons per hectare -			Percent
1960	2.54	--	--	--
1961	2.74	--	--	--
1962	2.54	--	--	--
1963	1.23	--	--	--
1964	2.45	--	--	--
1965	2.70	2.68	0.02	0.7
1966	2.43	2.64	-0.21	-8.6
1967	2.72	2.70	0.02	0.7
1968	3.14	2.71	0.43	13.7
1969	2.65	2.70	-0.05	-1.9
1970	2.07	2.61	-0.54	-26.1
1971	2.65	2.59	0.06	2.3
1972	2.50	2.60	-0.10	-4.0
1973	2.70	2.56	0.14	5.2
1974	2.80	2.52	0.28	10.0
1975	2.69	2.64	0.05	1.9
1976	2.49	2.63	-0.14	-5.6
1977	2.74	2.59	0.15	5.5
1978	3.28	3.46	-0.18	-5.5
1979	3.63	3.42	0.21	5.8
	Mean absolute value:		0.17	6.5
	Root mean square:		0.22	9.0

Sources: Table 2.7 and model estimates.

Figure 5.4
Actual and Estimated Barley Yield in Japan



Source: Table 5.4

Table 5.4--Actual and estimated barley yield

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	- Metric tons per hectare -			Percent
1960	2.75	--	--	--
1961	2.86	--	--	--
1962	2.82	--	--	--
1963	1.34	--	--	--
1964	2.51	--	--	--
1965	2.92	2.87	0.05	1.7
1966	2.85	2.84	0.01	0.4
1967	2.93	2.88	0.05	1.7
1968	3.23	2.89	0.34	10.5
1969	2.87	2.88	-0.01	-0.3
1970	2.54	2.82	-0.28	-11.0
1971	3.08	2.80	0.28	9.1
1972	2.67	2.81	-0.14	-5.2
1973	2.70	2.79	-0.09	-3.3
1974	3.01	2.75	0.26	8.6
1975	2.83	2.84	-0.01	-0.4
1976	2.62	2.84	-0.22	-8.4
1977	2.65	2.80	-0.15	-5.7
1978	3.39	3.48	-0.09	-2.7
1979	3.52	3.45	0.07	2.0
	Mean absolute value:		0.14	4.7
	Root mean square:		0.17	6.0

Sources: Table 2.7 and model estimates.

$$XR_t = PS_{t-1} * (YD_{t-1} + YD_{t-2} + YD_{t-3}) / 3$$

where subscripts identify time periods, and where:

XR = expected revenue (thousands of 1970 yen per hectare)

PS = supply price (1970 yen per kilogram)

YD = yield (metric tons per hectare)

To allow comparability over time, prices are converted into constant yen, with the consumer price index as deflator.

In the calculation of the average expected revenue across several grains, the previous year's areas are used as weights. A case certainly can be made for weighting with the current year's areas. However, because the ratios of the areas planted to rice, wheat, and barley have changed slowly and steadily, using lagged area weights makes virtually no difference in the regression equations--yet it greatly simplifies the calculation of the model as a whole. Thus the choice of lagged area weights is based on practical rather than theoretical considerations.

These, then, are the identities used to define expected revenues:

```
JPXRRIR  =  LAG1(JPPSRIR)  *
            ( LAG1(JPYDRI) + LAG2(JPYDRI) + LAG3(JPYDRI) )  /  3

JPXRWHR  =  LAG1(JPPSWHR)  *
            ( LAG1(JPYDWH) + LAG2(JPYDWH) + LAG3(JPYDWH) )  /  3

JPXRBAR  =  LAG1(JPPSBAR)  *
            ( LAG1(JPYDBA) + LAG2(JPYDBA) + LAG3(JPYDBA) )  /  3

JPXRWBR  =  ( JPXRWHR * LAG1(JPHAWH)  +  JPXRBAR * LAG1(JPHABA) )  /
            ( LAG1(JPHAWH) + LAG1(JPHABA) )

JPXRTGR  =  ( JPXRRIR * LAG1(JPHARI)  +  JPXRWHR * LAG1(JPHAWH)  +
              JPXRBAR * LAG1(JPHABA) )  /
            ( LAG1(JPHARI) + LAG1(JPHAWH) + LAG1(JPHABA) )
```

<u>where</u>:

* indicates multiplication

LAGn(x) is the value of "x" lagged by "n" years

and where:

JPXRaaR = Japan, expected revenue from aa (thousands of 1970 yen per hectare); with aa from the list:

- RI = rice
- WH = wheat
- BA = barley
- WB = wheat and barley
- TG = grains (rice, wheat, and barley)

JPPSaaR = Japan, supply price for aa (1970 yen per kilogram); with aa defined as above.

JPYDaa = Japan, yield for aa (metric tons per hectare); with aa defined as above.

JPHAaa = Japan, area planted to aa (thousand hectares); with aa defined as above.

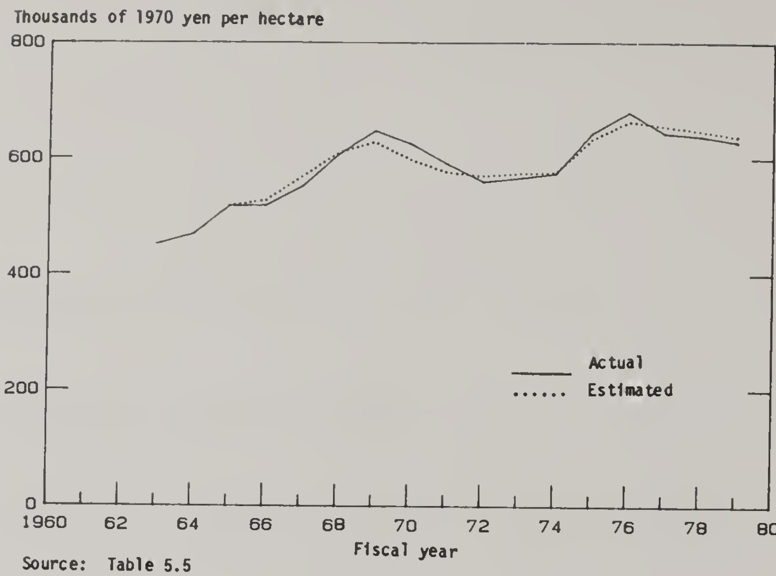
Tables 5.5 through 5.9 and Figures 5.5 through 5.9 show the expected revenues from rice, from wheat, and from barley; the area-weighted average expected revenue from wheat and barley; and the area-weighted average expected revenue from all three grains. The "actual values" listed in these tables are "actual" in the sense that they are based on true supply prices, true yields, and (in the case of cross-grain averages) true areas. Whether farmers really gauge expected revenue in the same way as does this model is another question.

It should be noted that it makes no difference if expected revenue as calculated here chronically underestimates realized revenue--as long as the bias is consistent. If farmers observe, for example, that realized revenue tends to be 5 percent above the level predicted by this model's formula for expected revenue, so that they consistently estimate expected revenue to be 1.05 times as large as the model's formulation, then all the regression equations used here still would apply. 3/

Tables 5.5 through 5.9 and the corresponding figures show both actual expected revenue and dynamically estimated expected revenue. Each of the dynamically estimated series depends upon lagged values of itself; each pulls itself up by its own bootstraps, as follows. (The reader may wish to refer to Figure 5.1 on page 111.) Historical values of prices, yields, and areas from the "pre-model" years 1962-64 are used to calculate the expected revenue for 1965. The 1965 expected revenue, along with other explanatory variables, is plugged into regression equations described later in this chapter, so as to estimate yields and areas in 1965. The estimated values of yields and areas in 1965 are combined with the true values of yields and areas in 1964 and 1963, to calculate the estimated expected revenue for 1966. The 1966 estimated expected revenue is used to estimate yields and areas in 1966. These are fed back into the calculations for the 1967 estimated expected revenue, and so on. In short, the dynamic estimates for expected revenue shown in Tables 5.5 through 5.9 are based on actual values of supply prices over the period 1964-78, actual values of areas and yields over the period 1962-64, and estimated values of areas and yields over the period 1965-78.

--Text continues to page 127.

Figure 5.5
Actual and Estimated Expected Revenue from Rice in Japan



Source: Table 5.5

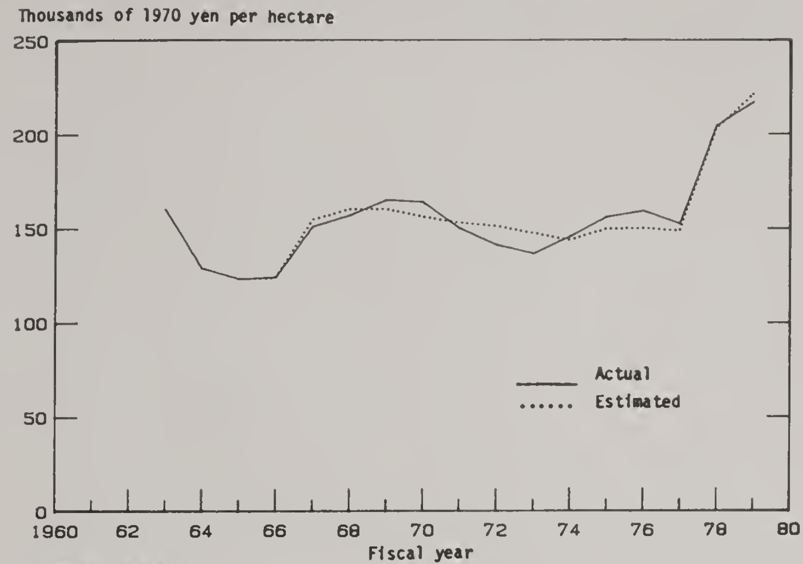
Table 5.5--Actual and estimated expected revenue from rice

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	Thousands of 1970 yen / hectare			Percent
1965	517.625	517.625	0.000	0.0
1966	517.936	527.320	-9.385	-1.8
1967	551.306	568.430	-17.124	-3.1
1968	607.260	610.257	-2.996	-0.5
1969	647.487	628.205	19.283	3.0
1970	624.758	597.615	27.143	4.3
1971	590.259	576.216	14.043	2.4
1972	559.858	570.029	-10.171	-1.8
1973	566.646	574.565	-7.919	-1.4
1974	574.481	576.661	-2.179	-0.4
1975	644.907	633.568	11.339	1.8
1976	680.356	664.705	15.652	2.3
1977	643.651	656.039	-12.387	-1.9
1978	638.333	647.618	-9.285	-1.5
1979	628.496	637.971	-9.475	-1.5
		Mean absolute value:	11.225	1.8
		Root mean square:	13.089	2.1

Note: Actual expected revenue is defined as the past year's actual supply price times the average of the past 3 years' actual yields. Estimated expected revenue is defined as the past year's actual supply price times the average of the past 3 years' estimated yields (except that for yields from years before 1965, actual values are used in place of estimated values).

Sources: Table 2.5 (for supply prices in 1970 yen), and Table 5.2 (for actual and estimated yields).

Figure 5.6
Actual and Estimated Expected Revenue from Wheat in Japan



Source: Table 5.6

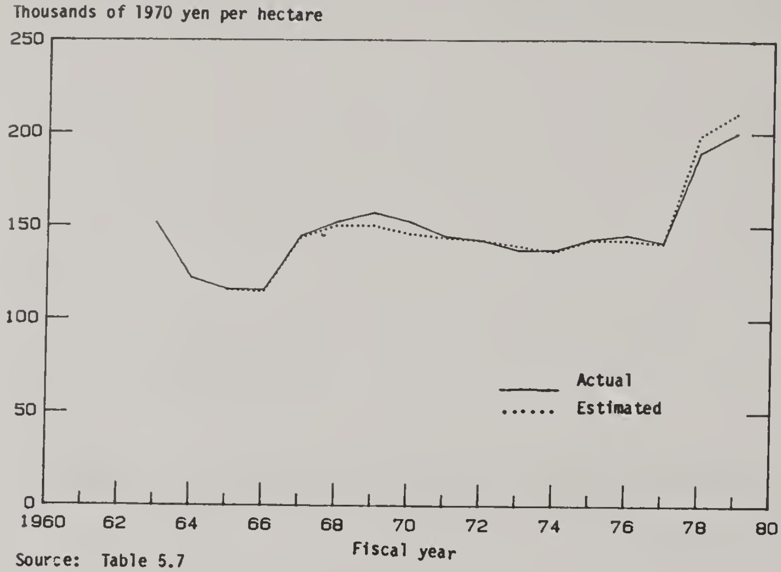
Table 5.6--Actual and estimated expected revenue from wheat

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	Thousands of 1970 yen / hectare			Percent
1965	123.096	123.096	0.000	0.0
1966	124.207	123.818	0.389	0.3
1967	150.868	154.650	-3.782	-2.5
1968	156.716	160.110	-3.394	-2.2
1969	164.864	160.091	4.773	2.9
1970	163.687	155.994	7.694	4.7
1971	149.812	152.861	-3.050	-2.0
1972	140.879	151.010	-10.131	-7.2
1973	136.284	147.232	-10.948	-8.0
1974	145.504	143.650	1.854	1.3
1975	155.842	149.609	6.234	4.0
1976	159.035	149.908	9.127	5.7
1977	152.131	148.509	3.622	2.4
1978	204.367	202.819	1.548	0.8
1979	216.587	220.914	-4.327	-2.0
		Mean absolute value:	4.725	3.1
		Root mean square:	5.771	3.9

Note: Actual expected revenue is defined as the past year's actual supply price times the average of the past 3 years' actual yields. Estimated expected revenue is defined as the past year's actual supply price times the average of the past 3 years' estimated yields (except that for yields from years before 1965, actual values are used in place of estimated values).

Sources: Table 2.5 (for supply prices in 1970 yen), and Table 5.3 (for actual and estimated yields).

Figure 5.7
Actual and Estimated Expected Revenue from Barley in Japan



Source: Table 5.7

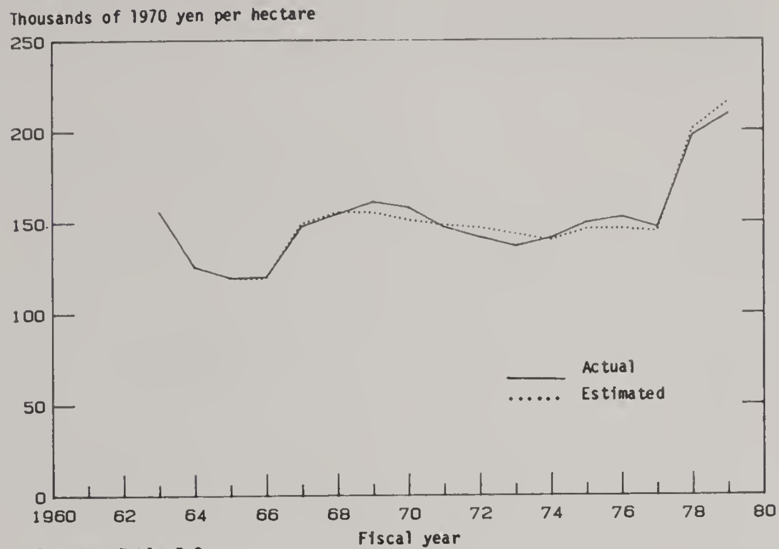
Table 5.7--Actual and estimated expected revenue from barley

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	Thousands of 1970 yen / hectare			Percent
1965	115.708	115.708	0.000	0.0
1966	115.536	114.683	0.853	0.7
1967	144.460	143.413	1.047	0.7
1968	152.151	150.227	1.924	1.3
1969	157.035	150.063	6.972	4.4
1970	152.253	145.846	6.407	4.2
1971	144.374	143.539	0.836	0.6
1972	142.214	142.382	-0.168	-0.1
1973	137.162	139.478	-2.316	-1.7
1974	137.269	136.456	0.812	0.6
1975	143.088	142.576	0.512	0.4
1976	145.360	142.636	2.723	1.9
1977	141.327	140.826	0.501	0.4
1978	189.867	198.774	-8.907	-4.7
1979	200.206	210.841	-10.635	-5.3
	Mean absolute value:		2.974	1.8
	Root mean square:		4.489	2.6

Note: Actual expected revenue is defined as the past year's actual supply price times the average of the past 3 years' actual yields. Estimated expected revenue is defined as the past year's actual supply price times the average of the past 3 years' estimated yields (except that for yields from years before 1965, actual values are used in place of estimated values).

Sources: Table 2.5 (for supply prices in 1970 yen), and Table 5.4 (for actual and estimated yields).

Figure 5.8
Actual and Estimated Expected Revenue
from Wheat and Barley in Japan



Source: Table 5.8

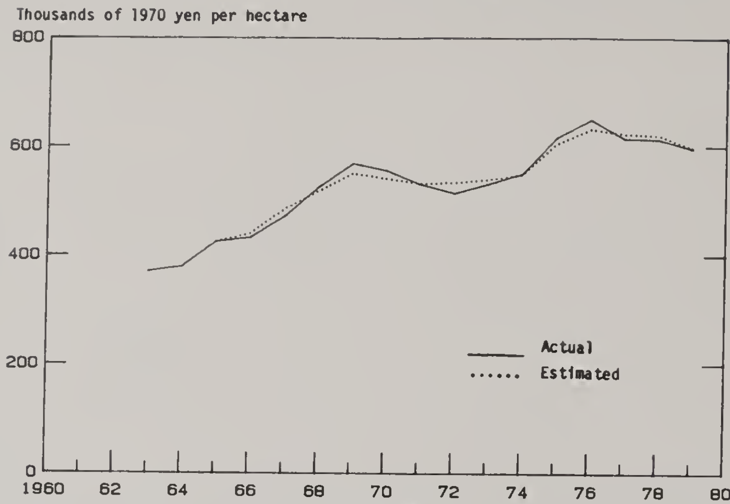
Table 5.8--Actual and estimated expected revenue from wheat and barley

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	Thousands of 1970 yen / hectare			Percent
1965	119.511	119.511	0.000	0.0
1966	120.132	119.441	0.691	0.6
1967	147.795	149.358	-1.564	-1.1
1968	154.481	155.450	-0.969	-0.6
1969	160.989	155.298	5.691	3.5
1970	158.005	151.149	6.855	4.3
1971	147.113	148.422	-1.309	-0.9
1972	141.541	146.882	-5.341	-3.8
1973	136.737	143.503	-6.766	-4.9
1974	141.251	140.173	1.078	0.8
1975	149.676	146.200	3.476	2.3
1976	152.666	146.368	6.299	4.1
1977	147.010	144.777	2.233	1.5
1978	197.480	200.863	-3.383	-1.7
1979	209.022	215.856	-6.834	-3.3
		Mean absolute value:	3.499	2.2
		Root mean square:	4.284	2.7

Note: Actual expected revenue is calculated as a weighted average of the actual expected revenues for wheat and for barley, with the past year's actual wheat and barley areas as weights. Estimated expected revenue is calculated as a weighted average of the estimated expected revenues for wheat and for barley, with the past year's estimated wheat and barley areas as weights.

Sources: Tables 5.6 and 5.7 (for actual and estimated expected revenues), Tables 5.16 and 5.17 (for actual and dynamically estimated areas).

Figure 5.9
Actual and Estimated Expected Revenue from Grains in Japan



Source: Table 5.9

Table 5.9--Actual and estimated expected revenue from grains

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	Thousands of 1970 yen / hectare			Percent
1965	425.104	425.104	0.000	0.0
1966	431.919	439.513	-7.594	-1.8
1967	470.961	484.364	-13.402	-2.8
1968	525.505	517.674	7.831	1.5
1969	568.236	550.449	17.787	3.1
1970	555.587	540.898	14.689	2.6
1971	530.569	531.827	-1.257	-0.2
1972	514.260	534.193	-19.933	-3.9
1973	531.520	539.926	-8.406	-1.6
1974	550.298	548.966	1.332	0.2
1975	617.384	605.861	11.523	1.9
1976	650.171	632.561	17.610	2.7
1977	615.117	624.221	-9.104	-1.5
1978	613.610	621.091	-7.482	-1.2
1979	596.823	598.640	-1.816	-0.3
		Mean absolute value:	9.318	1.7
		Root mean square:	11.217	2.0

Note: Actual expected revenue is calculated as a weighted average of the actual expected revenues for rice, for wheat, and for barley; with the past year's actual rice, wheat, and barley areas as weights. Estimated expected revenue is calculated as a weighted average of the estimated expected revenues for rice, wheat, and barley; with the past year's estimated rice, wheat, and barley areas as weights.

Sources: Tables 5.5, 5.6, and 5.7 (for actual and estimated expected revenues); Tables 5.12, 5.16, and 5.17 (for actual and dynamically estimated areas).

(In Chapter Seven, a dynamically simulated series of expected revenues will be generated, based on simulated instead of actual supply prices.)

A series of self-evident equations, listed as numbers [31] to [36] in the chapter summary, calculates the logarithms of expected revenue variables.

Expected Revenue from Off-Farm Employment

Due to land reform legislation and population pressure, Japan's agriculture is based on very small owner-operated units. Unlike the situation in most other industrialized countries, it is very difficult for farmers to obtain large-scale holdings. With their agricultural activities confined to small plots, Japanese farm families devote much of their time to off-farm employment. Indeed, more than half of the income received by farm households comes from nonagricultural jobs. The availability of off-farm work influences the extent of double cropping as well as the choice between labor-intensive crops like grains versus labor-extensive crops like fodder. In this model, the level of gross national product per capita in constant yen is used as a proxy for the availability and remunerativeness of off-farm employment. A more direct measure could have been used instead, such as the average industrial wage. But doing so would have required additional assumptions or equations to determine the industrial wage itself (for example), which is beyond the scope of the present model.

Because planting decisions typically have to be made near the beginning of the fiscal year, this model assumes that farmers base their decisions on the previous fiscal year's GNP per capita.

Expected Revenue from the Rice Diversion Payment

Contrary to prior expectations, no measure of the rice diversion payment enters any regression equation selected for use in the model. This section is written for researchers who are interested in modeling the effects of the rice diversion payment, or at least interested in how the author tried to do so.

Since 1969, the government has been paying farmers to divert riceland to other crops. The diversion payment is a lump sum per hectare, independent of the yield of the substitute crop. It is announced far enough in advance so that farmers can be assumed to know its value at planting time. For use in regression equations, the diversion payment is converted into a "log-ratio" form. That way the regression coefficient for the log-ratio measure of the diversion payment is directly comparable with the regression coefficient for the logarithm of expected revenue. The formula used to transform the diversion payment is:

JPLXRDP = LOG((JPXRRIR - JPDPRIR) / JPXRRIR)

where:

LOG is the natural logarithm operator

JPLXRDP = Japan, logarithm of ratio:
(rice expected revenue minus rice diversion payment) /
(rice expected revenue)

JPXRRIR = Japan, rice expected revenue
(thousands of 1970 yen per hectare)

JPDPRIR = Japan, rice diversion payment
(thousands of 1970 yen per hectare)

This definition implies that when the rice diversion payment is zero, the variable JPLXRDP also equals zero; and it implies that the value of JPLXRDP becomes increasingly negative when the rice diversion payment rises relative to the rice expected revenue. The negative sign reflects the nature of the diversion payment as an "opportunity cost" for growing rice (by growing rice, farmers lose the opportunity of collecting the diversion payment).

Table 5.10 shows the calculations behind the JPLXRDP series. The estimated values for JPLXRDP are based on actual values of the rice diversion payment and on dynamically estimated values of the rice expected revenue, obtained from Table 5.5 above. Figure 5.10 compares actual and dynamically estimated values of JPLXRDP.

Total Area

In the measurement of the gross total area planted, double-cropped land is counted twice. The gross total area planted is modeled here as a function of the average expected revenue for rice, wheat, and barley; the previous year's GNP per capita; and population, whose growth causes cities and towns to spread over farmlands. The regression equation used is:

$$
\begin{array}{llll}
JPLHATG = & 16.467461 & + \; 0.181713 \; JPLXRTG & - \; 0.551044 \; JPLPOPFY \\
& \pm 2.085765 & \pm 0.070713 & \pm 0.211553 \\
& (13.204) & (2.570) & (2.605) \\
& 0.01\% & 2.61\% & 2.45\%
\end{array}
$$

$$
\begin{array}{l}
- \; 0.383614 \; LAG1(JPLGNPFY) \\
\pm 0.049243 \\
(7.790) \\
0.01\%
\end{array}
$$

Adjusted R^2 = 97.45 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 1.378
Autocorrelation of residuals = 0.159

JPLHATG = Japan, logarithm of gross area planted to all crops
(thousand hectares)

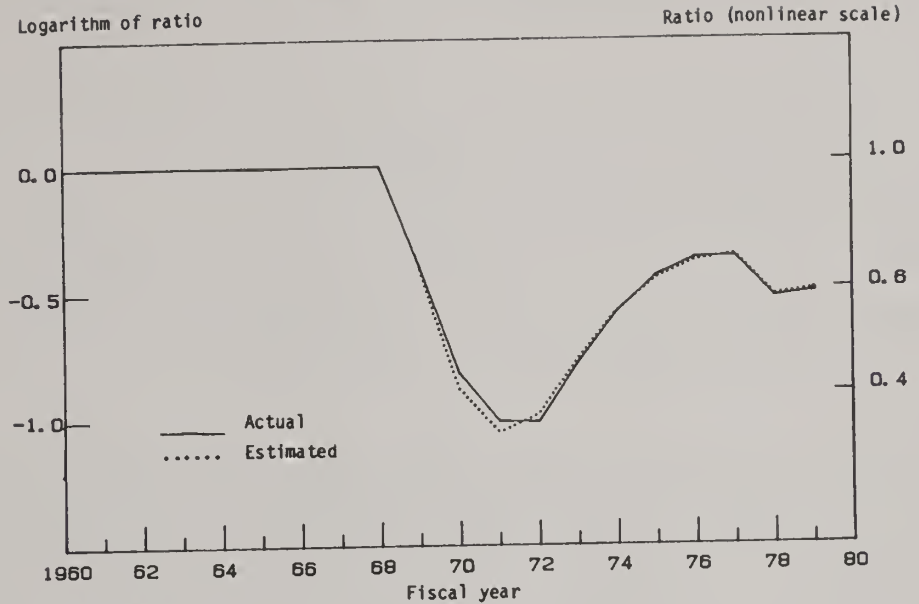
JPLXRTG = Japan, logarithm of average expected revenue from grains
(thousands of 1970 yen per hectare)

JPLPOPFY = Japan, logarithm of population on October 1 (thousands)

JPLGNPFY = Japan, logarithm of gross national product, fiscal year
(thousands of 1970 yen per capita)

LAG1(x) = value of "x" lagged by 1 year

Figure 5.10
Actual and Estimated Log-Ratio Measure of the Rice Diversion Payment



Source: Table 5.10

Table 5.10--Derivation of the log-ratio measure of the rice diversion payment

Fiscal year	Rice diversion payment	Rice expected revenue		Ratio measure		Log-ratio measure	
		Actual	Estimated	Actual	Estimated	Actual	Estimated
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Thousands of 1970 yen per hectare			------------- Unitless numbers -------------			
1965	0.	517.625	517.625	1.	1.	0.	0.
1966	0.	517.936	527.320	1.	1.	0.	0.
1967	0.	551.306	568.430	1.	1.	0.	0.
1968	0.	607.260	610.257	1.	1.	0.	0.
1969	211.953	647.487	628.205	0.67265	0.66261	-0.3965	-0.4116
1970	350.000	624.758	597.615	0.43978	0.41434	-0.8215	-0.8811
1971	375.298	590.259	576.216	0.36418	0.34869	-1.0101	-1.0536
1972	356.710	559.858	570.029	0.36285	0.37422	-1.0138	-0.9829
1973	307.133	566.646	574.565	0.45798	0.46545	-0.7809	-0.7647
1974	252.090	574.481	576.661	0.56119	0.56284	-0.5777	-0.5748
1975	228.113	644.907	633.568	0.64628	0.63995	-0.4365	-0.4464
1976	208.730	680.356	664.705	0.69321	0.68598	-0.3664	-0.3769
1977	195.608	643.651	656.039	0.69610	0.70184	-0.3623	-0.3541
1978	260.024	638.333	647.618	0.59265	0.59849	-0.5231	-0.5133
1979	248.159	628.496	637.971	0.60515	0.61102	-0.5023	-0.4926

Sources by column:

(1) Table 2.15

(2) Table 5.2

(3) Table 5.2

(4) Calculated as (4) = [(2) - (1)] / (2)

(5) Calculated as (5) = [(3) - (1)] / (3)

(6) Calculated as (6) = Log[(4)]

(7) Calculated as (7) = Log[(5)]

An obvious identity converts the regression results into the predicted total area, rounded off to the nearest thousand hectares:

JPHATG = ROUND(EXP(JPLHATG))

where:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

JPHATG = Japan, gross area planted to all crops (thousand hectares)

JPLHATG = Japan, logarithm of gross area planted to all crops (thousand hectares)

Table 5.11 and Figure 5.11 show the actual total area planted, static estimates of the total area planted, and dynamic estimates of the total area planted. The static estimates show how well the regression equation approximates the total area when it is used by itself, in isolation from the rest of the model. The dynamic estimates (calculated with estimated instead of actual values for JPLXRTG) show how well the regression equation approximates the total area when it is used in conjunction with the model as a whole, provided that Japanese price-setting policies are known. A table in Chapter Seven will show, as dynamic simulations, how well the total area is approximated when the model also encompasses policy making.

Allocation of Total Area to Individual Crops

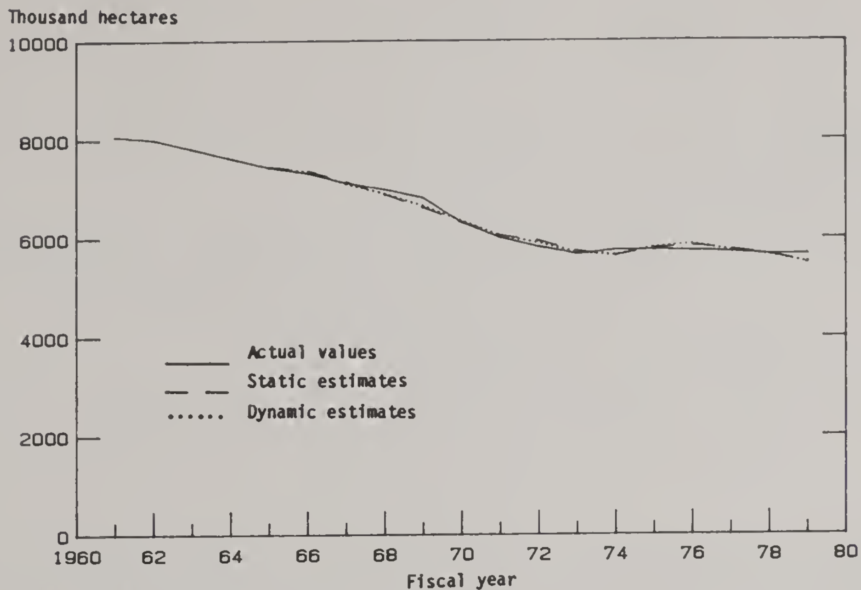
The total area can be split into its components in a number of ways. The "nested logit" approach used here has the advantages that it follows the logic of Japanese policy making, and that the meaning of each regression equation coefficient is clear. Other approaches can give slightly more accurate predictions of area allocations; but those approaches require the estimation of a larger number of coefficients, whose meaning is less evident and whose magnitude is sometimes dubious. 4/

The first step of the present approach is to split the rice area from the nonrice area. The nonrice area is then split into wheat plus barley versus other nonrice. Finally, the wheat area is separated from the barley area.

Rice Area versus Nonrice Area

The logarithm of the ratio of the rice area to the nonrice area is modeled as a function of the expected revenues from rice, wheat, and barley. (The level of gross national product per capita and the rice diversion payment were also tested as explanatory variables, but turned out to be insignificant.) The regression equation is:

Figure 5.11
Actual and Estimated Gross Area Planted to All Crops in Japan



Source: Table 5.11

Table 5.11--Actual and estimated gross area planted to all crops

Fiscal year	Actual value	Static estimation			Dynamic estimation		
		Estimate	Residual	Residual / actual	Estimate	Residual	Residual / actual
	---- Thousand hectares ----			Percent	Thousand hectares		Percent
1960	--	--	--	--	--	--	--
1961	8,071	--	--	--	--	--	--
1962	7,999	--	--	--	--	--	--
1963	7,813	--	--	--	--	--	--
1964	7,619	--	--	--	--	--	--
1965	7,430	7,449	-19	-0.3	7,449	-19	-0.3
1966	7,312	7,348	-36	-0.5	7,371	-59	-0.8
1967	7,112	7,106	6	0.1	7,142	-30	-0.4
1968	6,979	6,898	81	1.2	6,880	99	1.4
1969	6,809	6,653	156	2.3	6,615	194	2.8
1970	6,311	6,356	-45	-0.7	6,325	-14	-0.2
1971	6,001	6,048	-47	-0.8	6,051	-50	-0.8
1972	5,812	5,895	-83	-1.4	5,936	-124	-2.1
1973	5,663	5,710	-47	-0.8	5,726	-63	-1.1
1974	5,752	5,644	108	1.9	5,642	110	1.9
1975	5,755	5,811	-56	-1.0	5,792	-37	-0.6
1976	5,730	5,872	-142	-2.5	5,842	-112	-2.0
1977	5,707	5,747	-40	-0.7	5,763	-56	-1.0
1978	5,656	5,651	5	0.1	5,663	-7	-0.1
1979	5,662	5,491	171	3.0	5,494	168	3.0
	Mean absolute value:		69	1.1		76	1.2
	Root mean square:		86	1.4		94	1.5

Sources: Table 2.7 and model estimates.

$$\text{JPLHRINR} = \underset{\pm\,0.735085}{-\,4.181643} + \underset{\pm\,0.149757}{0.896910}\ \text{JPLXRRI} - \underset{\pm\,0.084842}{0.339649}\ \text{JPLXRWB}$$

	(5.689)	(5.989)	(4.003)
	0.01%	0.01%	0.18%

Adjusted R^2 = 70.76 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 1.368
Autocorrelation of residuals = 0.223

JPLHRINR = Japan, logarithm of ratio: (rice area) / (nonrice area)

JPLXRRI = Japan, logarithm of rice expected revenue (thousands of 1970 yen per hectare)

JPLXRWB = Japan, logarithm of average expected revenue from wheat and barley (thousands of 1970 yen per hectare)

Thus a 1 percent increase in the expected revenue from rice leads to a 0.9 percent rise in the ratio of the rice area to the nonrice area, while a 1 percent increase in the average expected revenue from wheat and barley leads to a 0.3 percent fall in the ratio of the rice area to the nonrice area. This also implies that if the expected revenues from rice, wheat, and barley each increase by 1 percent, then the ratio of the rice area to the nonrice area will rise by 0.6 percent (the difference between 0.9 and 0.3). 5/

The regression equation predicts the logarithm of the ratio of the rice area to the nonrice area. A series of identities (analogous to equations used in Chapter Four) transforms this log-ratio into the predicted rice and nonrice areas, both rounded off to the nearest thousand hectares:

JPHARINR = EXP(JPLHRINR)

JPHARI = ROUND(JPHATG * JPHARINR / (1.0 + JPHARINR))

JPHANR = JPHATG - JPHARI

where:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

JPHARINR = Japan, ratio: (rice area) / (nonrice area)

JPLHRINR = Japan, logarithm of ratio: (rice area) / (nonrice area)

JPHARI = Japan, rice area planted (thousand hectares)

JPHATG = Japan, gross area planted to all crops (thousand hectares)

JPHANR = Japan, nonrice area planted (thousand hectares)

Table 5.12 and Figure 5.12 compare the actual, statically estimated, and dynamically estimated values for the rice area planted. Each static estimate of JPHARI is derived from the static estimates of JPHATG and JPHARINR substituted into the second identity above; and the static estimate of JPHARINR, in turn, is a function of the actual values of JPLXRRI and JPLXRWB substituted into the previous regression equation. Each dynamic estimate of JPHARI is derived from the dynamic estimates of JPHATG and JPHARINR substituted into the second identity above; and the dynamic estimate of JPHARINR, in turn, is a function of the dynamic estimates of JPLXRRI and JPLXRWB substituted into the previous regression equation. The dynamic estimation of the rice area is part of the sequence of calculations which "pulls itself up by its own bootstraps" from year to year, as described previously in the section on expected crop revenues.

Table 5.13 shows the actual, statically estimated, and dynamically estimated values for the nonrice area.

Wheat Plus Barley Area versus Other Nonrice Area

The ratio of the area planted in wheat and barley to the area planted in other nonrice crops is modeled as a function of the average expected revenue from wheat and barley, and the gross national product per capita.

$$
\begin{array}{llll}
\text{JPLHWBON} = & 8.815184 & + \ 1.457413 \ \text{JPLXRWB} & - \ 2.819321 \ \text{LAG1(JPLGNPFY)} \\
 & \pm \ 1.591021 & \pm \ 0.374173 & \pm \ 0.227700 \\
 & (5.541) & (3.895) & (12.382) \\
 & 0.01\% & 0.21\% & 0.01\%
\end{array}
$$

Adjusted R^2 = 92.25 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 0.770
Autocorrelation of residuals = 0.607

JPLHWBON = Japan, logarithm of ratio:
(wheat plus barley area) / (other nonrice area)

JPLXRWB = Japan, logarithm of average expected revenue from wheat and barley (thousands of 1970 yen per hectare)

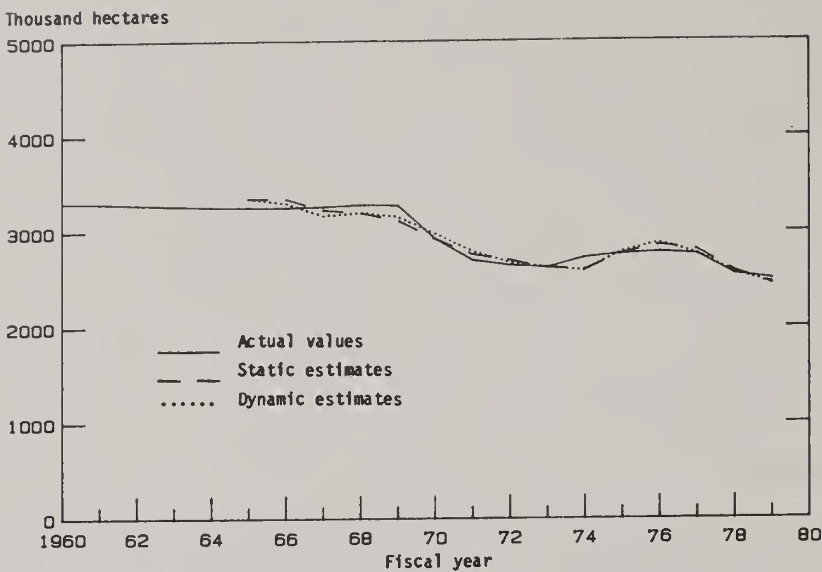
JPLGNPFY = Japan, logarithm of gross national product, fiscal year (thousands of 1970 yen per capita)

LAG1(x) = value of "x" lagged by 1 year

For obvious reasons, a rise in the expected revenue from wheat and barley tends to increase the area share planted to these crops.

The negative coefficient on income per capita probably reflects a practice of switching from labor-intensive crops like wheat and barley to less labor-intensive crops like fodder, whenever off-farm earnings opportunities improve. Fodder crops account for a large and increasing portion of the other nonrice land: their share grew from 16 percent of the other nonrice area in 1965 to 32 percent in 1979. 6/

Figure 5.12
Actual and Estimated Rice Area in Japan



Source: Table 5.12

Table 5.12--Actual and estimated rice area

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	---- Thousand hectares		----	Percent	Thousand hectares		Percent
1960	3,308	--	--	--	--	--	--
1961	3,301	--	--	--	--	--	--
1962	3,285	--	--	--	--	--	--
1963	3,272	--	--	--	--	--	--
1964	3,260	--	--	--	--	--	--
1965	3,255	3,351	-96	-2.9	3,351	-96	-2.9
1966	3,254	3,303	-49	-1.5	3,347	-93	-2.9
1967	3,263	3,169	94	2.9	3,227	36	1.1
1968	3,280	3,199	81	2.5	3,195	85	2.6
1969	3,274	3,157	117	3.6	3,115	159	4.9
1970	2,923	2,976	-53	-1.8	2,922	1	0.0
1971	2,695	2,791	-96	-3.6	2,756	-61	-2.3
1972	2,640	2,671	-31	-1.2	2,694	-54	-2.0
1973	2,620	2,619	1	0.0	2,620	0	0.0
1974	2,724	2,590	134	4.9	2,598	126	4.6
1975	2,764	2,789	-25	-0.9	2,768	-4	-0.1
1976	2,779	2,878	-99	-3.6	2,854	-75	-2.7
1977	2,757	2,764	-7	-0.3	2,804	-47	-1.7
1978	2,548	2,566	-18	-0.7	2,582	-34	-1.3
1979	2,497	2,449	48	1.9	2,453	44	1.8
	Mean absolute value:		63	2.1		61	2.1
	Root mean square:		75	2.5		75	2.5

Sources: Table 2.7 and model estimates.

Table 5.13--Actual and estimated nonrice area

Fiscal year	Actual value	Static estimation			Dynamic estimation		
		Estimate	Residual	Residual / actual	Estimate	Residual	Residual / actual
	---- Thousand hectares		----	Percent	Thousand hectares		Percent
1960	--	--	--	--	--	--	--
1961	4,770	--	--	--	--	--	--
1962	4,714	--	--	--	--	--	--
1963	4,541	--	--	--	--	--	--
1964	4,359	--	--	--	--	--	--
1965	4,175	4,098	77	1.8	4,098	77	1.8
1966	4,058	4,045	13	0.3	4,024	34	0.8
1967	3,849	3,937	-88	-2.3	3,915	-66	-1.7
1968	3,699	3,699	0	0.0	3,685	14	0.4
1969	3,535	3,496	39	1.1	3,500	35	1.0
1970	3,388	3,380	8	0.2	3,403	-15	-0.4
1971	3,306	3,257	49	1.5	3,295	11	0.3
1972	3,172	3,224	-52	-1.6	3,242	-70	-2.2
1973	3,043	3,091	-48	-1.6	3,106	-63	-2.1
1974	3,028	3,054	-26	-0.9	3,044	-16	-0.5
1975	2,991	3,022	-31	-1.0	3,024	-33	-1.1
1976	2,951	2,994	-43	-1.5	2,988	-37	-1.3
1977	2,950	2,983	-33	-1.1	2,959	-9	-0.3
1978	3,108	3,085	23	0.7	3,081	27	0.9
1979	3,165	3,042	123	3.9	3,041	124	3.9
	Mean absolute value:		44	1.3		42	1.3
	Root mean square:		54	1.6		52	1.6

Sources: Table 2.7 and model estimates.

Next a series of identities subdivides the estimated nonrice area into the estimated wheat plus barley area and the estimated other nonrice area. The estimated wheat and barley area is rounded off to the nearest 0.1 thousand hectares, to match the precision with which the true wheat and barley areas are reported.

JPHAWBON = EXP(JPLHWBON)

JPHAWB = ROUND(JPHANR * JPHAWBON / (1.0 + JPHAWBON), 0.1)

JPHAON = ROUND(JPHANR - JPHAWB)

where:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

ROUND(x,0.1) rounds off "x" to the nearest tenth of an integer

and where:

JPHAWBON = Japan, ratio: (wheat plus barley area) / (other nonrice area)

JPLHWBON = Japan, logarithm of ratio:
(wheat plus barley area) / (other nonrice area)

JPHAWB = Japan, wheat plus barley area planted (thousand hectares)

JPHANR = Japan, nonrice area planted (thousand hectares)

JPHAON = Japan, other nonrice area planted (thousand hectares)

Table 5.14 and Figure 5.13 compare the actual, statically estimated, and dynamically estimated values for the other nonrice area. Table 5.15 does the same for the wheat plus barley area.

Wheat Area versus Barley Area

Finally, the wheat area is split from the barley area as a function of the ratio of the wheat expected revenue to the barley expected revenue:

$$
\begin{array}{lll}
\text{JPLHWHBA} = & -\ 0.053372 & +\ 2.218002\ \text{JPLRWHBA} \\
 & \pm\ 0.027495 & \pm\ 0.447094 \\
 & (1.941) & (4.961) \\
 & 7.42\% & 0.03\%
\end{array}
$$

Adjusted R^2 = 62.78 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 0.901
Autocorrelation of residuals = 0.271

JPLHWHBA = Japan, logarithm of ratio: (wheat area) / (barley area)

JPLRWHBA = Japan, logarithm of ratio: (wheat expected revenue) / (barley expected revenue)

The government-set price ratio of wheat to barley remained fixed at 1.14 from 1961 through 1976. In 1977, the price ratio fell to 1.10 and stayed there through the end of the regression period. Thus fluctuations in the ratio of expected revenues were entirely due to fluctuations in relative yields, except in 1978 (given the year's delay between the 1977 price changes and their effect on expected revenue).

A set of identities converts the regression results into the implied wheat and barley areas, each rounded off to the nearest 0.1 thousand hectares:

JPHAWHBA = EXP(JPLHWHBA)

JPHAWH = ROUND(JPHAWB * JPHAWHBA / (1.0 + JPHAWHBA), 0.1)

JPHABA = JPHAWB - JPHAWH

where:

EXP is the exponentiation (e^x) operator

ROUND(x,0.1) rounds off "x" to the nearest tenth of an integer

JPHAWHBA = Japan, ratio: (wheat area) / (barley area)

JPLHWHBA = Japan, logarithm of ratio: (wheat area) / (barley area)

JPHAWH = Japan, wheat area planted (thousand hectares)

JPHAWB = Japan, wheat plus barley area planted (thousand hectares)

JPHABA = Japan, barley area planted (thousand hectares)

Table 5.16 and Figure 5.14 display the actual, statically estimated, and dynamically estimated wheat areas. Table 5.17 and Figure 5.15 make the same comparisons for barley.

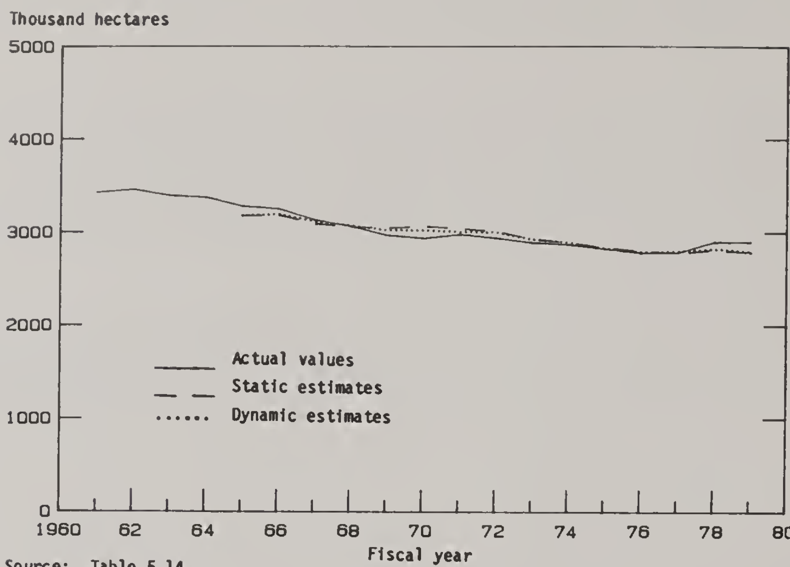
QUANTITIES SUPPLIED

For rice, wheat, and barley, estimated supply is derived from its identity to estimated yield times estimated area. Production is estimated statically or dynamically, depending on whether the static or dynamic estimate of area is substituted into the identity. Because yield estimates do not depend on any lagged endogenous variable, the same set of yield estimates is used to calculate both static and dynamic estimates of production. All estimates of the quantity supplied are rounded off to the nearest thousand metric tons. Hence:

--Text continues to page 142.

Figure 5.13

Actual and Estimated Other Nonrice Area in Japan



Source: Table 5.14

Table 5.14--Actual and estimated other nonrice area

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	---- Thousand hectares	----	----	Percent	Thousand hectares		Percent
1960	--	--	--	--	--	--	--
1961	3,429	--	--	--	--	--	--
1962	3,459	--	--	--	--	--	--
1963	3,391	--	--	--	--	--	--
1964	3,372	--	--	--	--	--	--
1965	3,277	3,179	98	3.0	3,179	98	3.0
1966	3,249	3,195	54	1.7	3,184	65	2.0
1967	3,130	3,118	12	0.4	3,090	40	1.3
1968	3,061	3,073	-12	-0.4	3,056	5	0.2
1969	2,965	3,022	-57	-1.9	3,047	-82	-2.8
1970	2,933	3,024	-91	-3.1	3,065	-132	-4.5
1971	2,976	3,008	-32	-1.1	3,040	-64	-2.2
1972	2,937	3,001	-64	-2.2	3,007	-70	-2.4
1973	2,888	2,926	-38	-1.3	2,929	-41	-1.4
1974	2,868	2,895	-27	-0.9	2,887	-19	-0.7
1975	2,823	2,833	-10	-0.4	2,841	-18	-0.6
1976	2,782	2,793	-11	-0.4	2,799	-17	-0.6
1977	2,786	2,801	-15	-0.5	2,782	4	0.1
1978	2,900	2,825	75	2.6	2,816	84	2.9
1979	2,900	2,799	101	3.5	2,788	112	3.9
	Mean absolute value:		46	1.6		57	1.9
	Root mean square:		57	1.9		69	2.3

Note: The other nonrice area is defined as the gross total area planted less the areas planted to rice, wheat, and barley.

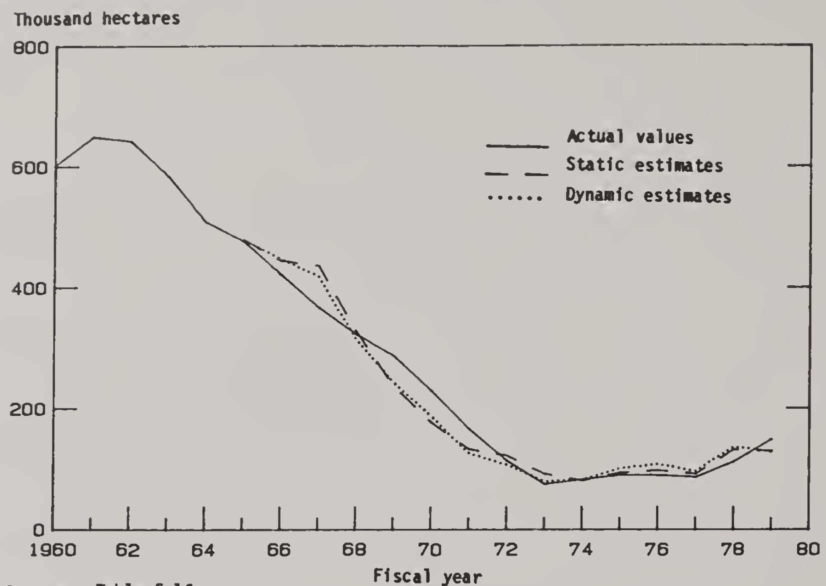
Sources: Table 2.7 and model estimates.

Table 5.15--Actual and estimated wheat plus barley area

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	Thousand hectares			Percent	Thousand hectares		Percent
1960	1,440.	--	--	--	--	--	--
1961	1,341.	--	--	--	--	--	--
1962	1,255.	--	--	--	--	--	--
1963	1,150.	--	--	--	--	--	--
1964	987.0	--	--	--	--	--	--
1965	898.0	919.3	-21.3	-2.4	919.3	-21.3	-2.4
1966	809.0	849.9	-40.9	-5.1	839.9	-30.9	-3.8
1967	719.0	819.4	-100.4	-14.0	824.8	-105.8	-14.7
1968	638.3	626.4	11.9	1.9	628.7	9.6	1.5
1969	569.6	473.9	95.7	16.8	453.3	116.3	20.4
1970	455.0	356.1	98.9	21.7	338.3	116.7	25.6
1971	329.7	249.1	80.6	24.4	255.0	74.7	22.7
1972	234.9	222.7	12.2	5.2	235.4	-0.5	-0.2
1973	154.9	165.3	-10.4	-6.7	177.5	-22.6	-14.6
1974	160.3	158.8	1.5	0.9	156.6	3.7	2.3
1975	167.7	188.8	-21.1	-12.6	183.0	-15.3	-9.1
1976	169.4	201.0	-31.6	-18.7	189.4	-20.0	-11.8
1977	163.8	182.3	-18.5	-11.3	177.0	-13.2	-8.1
1978	208.1	259.7	-51.6	-24.8	265.3	-57.2	-27.5
1979	264.6	242.7	21.9	8.3	253.3	11.3	4.3
	Mean absolute value:		41.2	11.6		41.3	11.3
	Root mean square:		53.5	14.1		57.8	14.4

Sources: Table 2.7 and model estimates.

Figure 5.14
Actual and Estimated Wheat Area in Japan



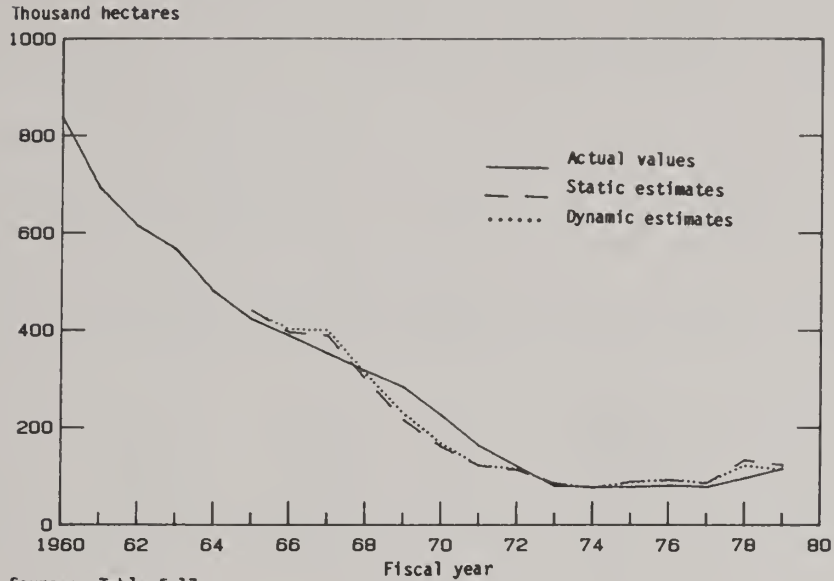
Source: Table 5.16

Table 5.16--Actual and estimated wheat area

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	---- Thousand hectares ----			Percent	Thousand hectares		Percent
1960	602.0	--	--	--	--	--	--
1961	649.0	--	--	--	--	--	--
1962	642.0	--	--	--	--	--	--
1963	584.0	--	--	--	--	--	--
1964	508.0	--	--	--	--	--	--
1965	476.0	478.9	-2.9	-0.6	478.9	-2.9	-0.6
1966	421.0	447.7	-26.7	-6.3	444.4	-23.4	-5.6
1967	367.0	418.5	-51.5	-14.0	435.9	-68.9	-18.8
1968	322.4	315.1	7.3	2.3	328.2	-5.8	-1.8
1969	286.5	243.4	43.1	15.0	236.9	49.6	17.3
1970	229.2	187.6	41.6	18.2	177.2	52.0	22.7
1971	166.3	126.3	40.0	24.1	133.0	33.3	20.0
1972	113.7	107.2	6.5	5.7	122.2	-8.5	-7.5
1973	74.9	79.9	-5.0	-6.7	91.7	-16.8	-22.4
1974	82.8	82.4	0.4	0.5	80.7	2.1	2.5
1975	89.6	100.8	-11.2	-12.5	93.9	-4.3	-4.8
1976	89.1	107.8	-18.7	-21.0	97.4	-8.3	-9.3
1977	86.0	96.2	-10.2	-11.9	91.4	-5.4	-6.3
1978	112.0	137.0	-25.0	-22.3	132.1	-20.1	-17.9
1979	149.0	128.7	20.3	13.6	129.8	19.2	12.9
	Mean absolute value:		20.7	11.6		21.4	11.4
	Root mean square:		26.2	13.8		29.3	13.7

Sources: Table 2.7 and model estimates.

Figure 5.15
Actual and Estimated Barley Area in Japan



Source: Table 5.17

Table 5.17--Actual and estimated barley area

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	---- Thousand hectares ----			Percent	Thousand hectares		Percent
1960	838.0	--	--	--	--	--	--
1961	692.0	--	--	--	--	--	--
1962	613.0	--	--	--	--	--	--
1963	566.0	--	--	--	--	--	--
1964	479.0	--	--	--	--	--	--
1965	422.0	440.4	-18.4	-4.4	440.4	-18.4	-4.4
1966	388.0	402.2	-14.2	-3.7	395.5	-7.5	-1.9
1967	352.0	400.9	-48.9	-13.9	388.9	-36.9	-10.5
1968	315.9	311.3	4.6	1.5	300.5	15.4	4.9
1969	283.1	230.5	52.6	18.6	216.4	66.7	23.6
1970	225.8	168.5	57.3	25.4	161.1	64.7	28.7
1971	163.4	122.8	40.6	24.8	122.0	41.4	25.3
1972	121.2	115.5	5.7	4.7	113.2	8.0	6.6
1973	80.0	85.4	-5.4	-6.7	85.8	-5.8	-7.3
1974	77.5	76.4	1.1	1.4	75.9	1.6	2.1
1975	78.1	88.0	-9.9	-12.7	89.1	-11.0	-14.1
1976	80.3	93.2	-12.9	-16.1	92.0	-11.7	-14.6
1977	77.8	86.1	-8.3	-10.7	85.6	-7.8	-10.0
1978	96.1	122.7	-26.6	-27.7	133.2	-37.1	-38.6
1979	115.6	114.0	1.6	1.4	123.5	-7.9	-6.8
	Mean absolute value:		20.5	11.6		22.8	13.3
	Root mean square:		28.0	14.6		30.8	17.0

Sources: Table 2.7 and model estimates.

```
JPQSRIFY  =  ROUND( JPYDRI * JPHARI )

JPQSWHFY  =  ROUND( JPYDWH * JPHAWH )

JPQSBAFY  =  ROUND( JPYDBA * JPHABA )
```

where:

```
* indicates multiplication

ROUND(x)  rounds off "x" to the nearest integer

JPQSaaFY = Japan, quantity supplied of aa, fiscal year
           (thousand metric tons); with aa from the list:

             RI = rice
             WH = wheat
             BA = barley

JPYDaa   = Japan, yield for aa (metric tons per hectare);
           with aa defined as above.

JPHAaa   = Japan, area planted to aa (thousand hectares);
           with aa defined as above.
```

Tables 5.18 through 5.20 compare the actual and estimated quantities supplied of rice, wheat, and barley. These quantities are not graphed; but virtually the same information is conveyed later in Figures 5.19 to 5.21, which display production net of seed used.

The error (residual) for each production estimate can be decomposed into a portion attributable to the error in the yield estimate and a portion attributable to the error in the area estimate. The weights used for this attribution are proportional to the error in the estimated logarithm of yield or area, since:

(Supply) = (Yield) * (Area)

implies that:

LOG(Supply) = LOG(Yield) + LOG(Area)

which implies that:

Error in LOG(Supply) = Error in LOG(Yield) + Error in LOG(Area)

Therefore the residual for the quantity supplied is split as follows:

(Residual due to error in yield estimate) =

(Residual for supply) * [Error in LOG(Yield)] / [Error in LOG(Supply)]

(Residual due to error in area estimate) =

(Residual for supply) * [Error in LOG(Area)] / [Error in LOG(Supply)]

Table 5.18--Actual and estimated rice supply

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	12,858	--	--	--	--	--	--
1961	12,419	--	--	--	--	--	--
1962	13,009	--	--	--	--	--	--
1963	12,812	--	--	--	--	--	--
1964	12,584	--	--	--	--	--	--
1965	12,409	13,471	-1,062	-8.6	13,471	-1,062	-8.6
1966	12,745	13,443	-698	-5.5	13,622	-877	-6.9
1967	14,453	13,088	1,365	9.4	13,328	1,125	7.8
1968	14,449	13,372	1,077	7.5	13,355	1,094	7.6
1969	14,003	13,386	617	4.4	13,208	795	5.7
1970	12,689	12,797	-108	-0.9	12,565	124	1.0
1971	10,887	12,141	-1,254	-11.5	11,989	-1,102	-10.1
1972	11,889	11,779	110	0.9	11,881	8	0.1
1973	12,149	11,707	442	3.6	11,711	438	3.6
1974	12,292	11,733	559	4.5	11,769	523	4.3
1975	13,165	12,802	363	2.8	12,705	460	3.5
1976	11,772	13,383	-1,611	-13.7	13,271	-1,499	-12.7
1977	13,095	13,018	77	0.6	13,207	-112	-0.9
1978	12,589	12,265	324	2.6	12,342	247	2.0
1979	11,958	11,853	105	0.9	11,873	85	0.7
Residual from all causes							
		Mean absolute value:	651	5.2		637	5.0
		Root mean square:	815	6.5		784	6.2
Residual from error in yield							
		Mean absolute value:	467	3.7		467	3.7
		Root mean square:	576	4.6		576	4.6
Residual from error in area							
		Mean absolute value:	272	2.1		263	2.1
		Root mean square:	323	2.6		323	2.5

Notes: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

See page 142 for an explanation of how each residual was split into a component due to the error in estimated yield plus a component due to the error in estimated area.

Sources: Table 5.1 and model estimates.

Table 5.19--Actual and estimated wheat supply

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	1,531	--	--	--	--	--	--
1961	1,781	--	--	--	--	--	--
1962	1,631	--	--	--	--	--	--
1963	716	--	--	--	--	--	--
1964	1,244	--	--	--	--	--	--
1965	1,287	1,283	4	0.3	1,283	4	0.3
1966	1,024	1,182	-158	-15.4	1,173	-149	-14.6
1967	997	1,130	-133	-13.3	1,177	-180	-18.1
1968	1,012	854	158	15.6	889	123	12.2
1969	758	657	101	13.3	640	118	15.6
1970	474	490	-16	-3.4	462	12	2.5
1971	440	327	113	25.7	344	96	21.8
1972	284	279	5	1.8	318	-34	-12.0
1973	202	205	-3	-1.5	235	-33	-16.3
1974	232	208	24	10.3	203	29	12.5
1975	241	266	-25	-10.4	248	-7	-2.9
1976	222	284	-62	-27.9	256	-34	-15.3
1977	236	249	-13	-5.5	237	-1	-0.4
1978	367	474	-107	-29.2	457	-90	-24.5
1979	541	440	101	18.7	444	97	17.9
Residual from all causes							
		Mean absolute value:	68	12.8		67	12.5
		Root mean square:	89	15.8		87	14.5
Residual from error in yield							
		Mean absolute value:	34	6.4		34	6.4
		Root mean square:	53	8.6		53	8.5
Residual from error in area							
		Mean absolute value:	56	11.8		58	11.5
		Root mean square:	70	14.1		78	14.0

Note: See page 142 for an explanation of how each residual was split into a component due to the error in estimated yield plus a component due to the error in estimated area.

Sources: Table 5.1 and model estimates.

Table 5.20--Actual and estimated barley supply

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	2,301	--	--	--	--	--	--
1961	1,976	--	--	--	--	--	--
1962	1,726	--	--	--	--	--	--
1963	759	--	--	--	--	--	--
1964	1,202	--	--	--	--	--	--
1965	1,234	1,264	-30	-2.4	1,264	-30	-2.4
1966	1,105	1,142	-37	-3.3	1,123	-18	-1.6
1967	1,032	1,155	-123	-11.9	1,120	-88	-8.5
1968	1,021	900	121	11.9	868	153	15.0
1969	812	664	148	18.2	623	189	23.3
1970	573	475	98	17.1	454	119	20.8
1971	503	344	159	31.6	342	161	32.0
1972	324	325	-1	-0.3	318	6	1.9
1973	216	238	-22	-10.2	239	-23	-10.6
1974	233	210	23	9.9	209	24	10.3
1975	221	250	-29	-13.1	253	-32	-14.5
1976	210	265	-55	-26.2	261	-51	-24.3
1977	206	241	-35	-17.0	240	-34	-16.5
1978	326	427	-101	-31.0	464	-138	-42.3
1979	407	393	14	3.4	426	-19	-4.7
Residual from all causes							
Mean absolute value:			66	13.8		72	15.2
Root mean square:			84	16.8		94	19.0
Residual from error in yield							
Mean absolute value:			23	4.6		23	4.6
Root mean square:			35	5.8		34	5.8
Residual from error in area							
Mean absolute value:			59	11.7		66	13.4
Root mean square:			80	14.8		89	17.2

Note: See page 142 for an explanation of how each residual was split into a component due to the error in estimated yield plus a component due to the error in estimated area.

Sources: Table 5.1 and model estimates.

Tables 5.18 through 5.20 show the mean absolute value and the root mean square of both the portion of each residual attributable to the error in yield and the portion of each residual attributable to the error in area. Errors in yield estimation account for most of the inaccuracy in rice supply estimates, whereas errors in area estimation account for most of the inaccuracy in wheat and barley supply estimates.

SEED USED

Seed usage appears as a separate category mainly because there seemed to be no good way of including it elsewhere. The quantities of seed used are small enough so that even large percentage errors in estimates for seed have little effect on estimates for net trade. Thus a crude approximation of seed usage is satisfactory.

Two approaches were assayed: that the quantity of seed used is proportional to the area planted, or that it is proportional to the quantity produced. The relevant data are shown in Table 5.21 and in Figures 5.16 to 5.18.

A time trend for the rice seeding rate proved insignificant, and the levels of wheat and barley seed usage are so small that fine-tuning their estimation has no practical effect. (The regressed time trends are presented at the end of this chapter.) The model simply assumes that the quantity of seed used per ton of rice, wheat, or barley produced will continue at a rate similar to recent years' experience. Thus seed usage, rounded off to the nearest thousand metric tons, is estimated according to the equations below:

JPQZRIFY = ROUND(0.0075 * JPQSRIFY)

JPQZWHFY = ROUND(0.04 * JPQSWHFY)

JPQZBAFY = ROUND(0.025 * JPQSBAFY)

where:

ROUND(x) rounds off "x" to the nearest integer

JPQZaaFY = Japan, quantity of aa used as seed, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley

JPQSaaFY = Japan, quantity supplied of aa, fiscal year (thousand metric tons); with aa defined as above.

The resultant estimates are compared to actual values in Tables 5.22 through 5.24.

Major Grain Crops: Rice, Wheat, and Barley

For rice, wheat, and barley, the obvious identity determines production net of seed used:

JPQPRIFY = JPQSRIFY - JPQZRIFY

JPQPWHFY = JPQSWHFY - JPQZWHFY

JPQPBAFY = JPQSBAFY - JPQZBAFY

where:

JPQPaaFY = Japan, production of aa net of seed used, fiscal year (thousand metric tons); with aa from the list:

RI = rice
WH = wheat
BA = barley

JPQSaaFY = Japan, quantity supplied of aa, fiscal year (thousand metric tons); with aa defined as above.

JPQZaaFY = Japan, quantity of aa used as seed, fiscal year (thousand metric tons); with aa defined as above.

In Tables 5.25 to 5.27 and in Figures 5.19 to 5.21, the static and dynamic estimates obtained from these identities are compared to the actual values for production net of seed used.

Minor Grain Crops: Corn and Other Grain

Corn production net of seed used is estimated as a time trend, according to the regression equation below:

$$\begin{array}{lll} JPLQPCNF = & 472.577 & - \ 0.238086 * YEAR \\ & \pm 37.622 & \pm 0.019044 \\ & (12.561) & (12.502) \\ & 0.01\% & 0.01\% \end{array}$$

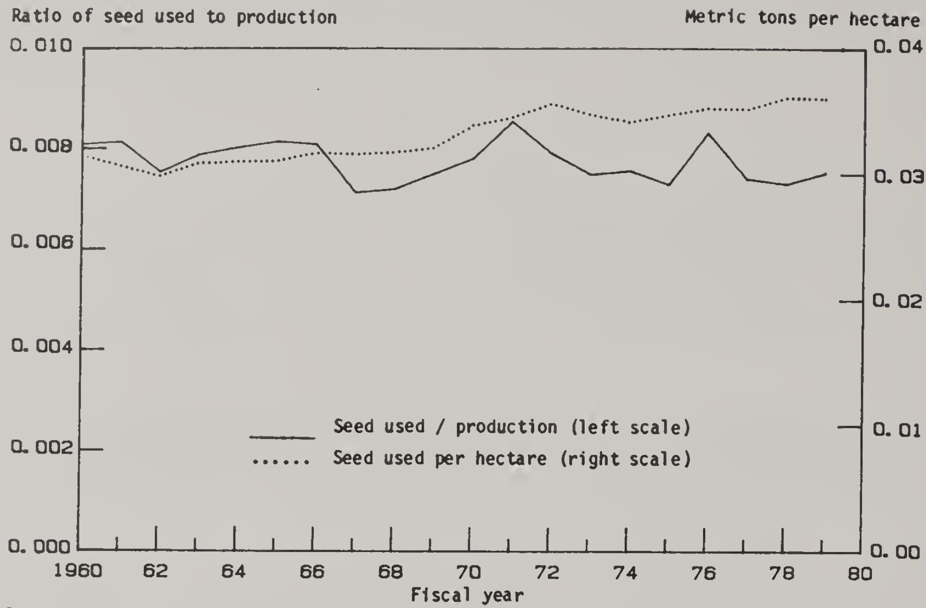
Adjusted R^2 = 95.69 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 1.989
Autocorrelation of residuals = 0.027

JPLQPCNF = Japan, logarithm of corn production net of seed used, fiscal year (thousand metric tons)

YEAR = Japanese fiscal year (values from 1972 to 1979)

--Text continues to page 156.

Figure 5.16
Rice Seed Usage Rates in Japan



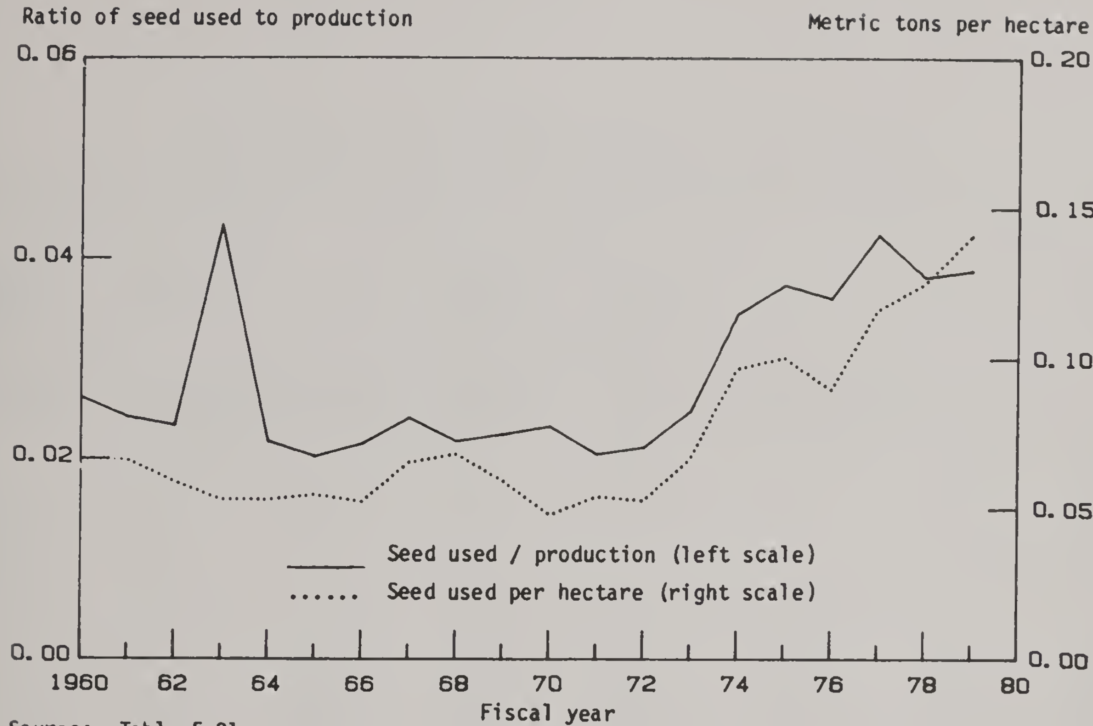
Source: Table 5.21

Table 5.21--Seed usage rates

Fiscal year	Seed use per hectare planted			Seed use / production		
	Rice	Wheat	Barley	Rice	Wheat	Barley
	------ Metric tons / hectare ------			-------------- Ratio --------------		
1960	0.0314389	0.066445	0.0501193	0.00808835	0.0261267	0.0182529
1961	0.0305968	0.066256	0.0534682	0.00813270	0.0241437	0.0187247
1962	0.0298326	0.059190	0.0570962	0.00753325	0.0232986	0.0202781
1963	0.0308680	0.053082	0.0477032	0.00788323	0.0432961	0.0355731
1964	0.0309816	0.053150	0.0480167	0.00802606	0.0217042	0.0191348
1965	0.0310292	0.054622	0.0473934	0.00813925	0.0202020	0.0162075
1966	0.0316533	0.052257	0.0489691	0.00808160	0.0214844	0.0171946
1967	0.0315660	0.065395	0.0625000	0.00712655	0.0240722	0.0213178
1968	0.0317073	0.068238	0.0569801	0.00719773	0.0217391	0.0176298
1969	0.0320709	0.059337	0.0494525	0.00749839	0.0224274	0.0172414
1970	0.0338693	0.047993	0.0442870	0.00780203	0.0232068	0.0174520
1971	0.0345083	0.054119	0.0489596	0.00854230	0.0204545	0.0159046
1972	0.0356061	0.052770	0.0412541	0.00790647	0.0211268	0.0154321
1973	0.0347328	0.066756	0.0625000	0.00749033	0.0247525	0.0231481
1974	0.0341410	0.096618	0.0645161	0.00756590	0.0344828	0.0214592
1975	0.0347323	0.100446	0.0768246	0.00729206	0.0373444	0.0271493
1976	0.0352645	0.089787	0.0622665	0.00832484	0.0360360	0.0238095
1977	0.0351832	0.116279	0.0642674	0.00740741	0.0423729	0.0242718
1978	0.0361068	0.125000	0.0832466	0.00730797	0.0381471	0.0245399
1979	0.0360433	0.140940	0.0951557	0.00752634	0.0388170	0.0270270

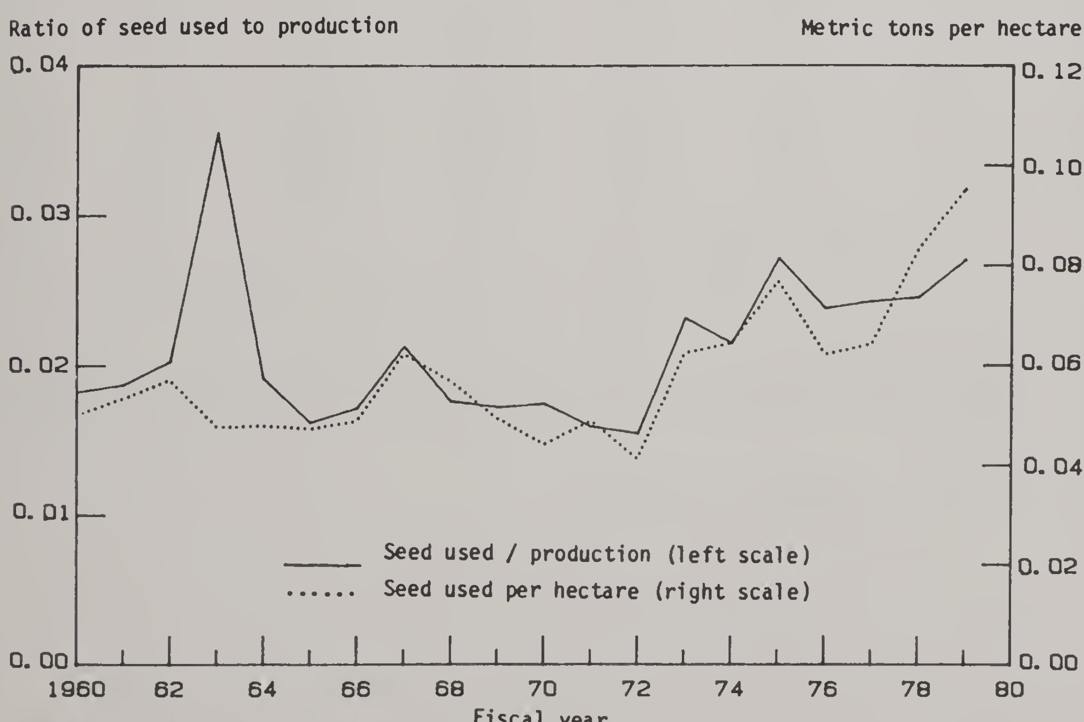
Sources: Calculated on the basis of data in Table 2.7 (for areas) and Table 5.1 (for production and seed use).

Figure 5.17
Wheat Seed Usage Rates in Japan



Source: Table 5.21

Figure 5.18
Barley Seed Usage Rates in Japan



Source: Table 5.21

Table 5.22--Actual and estimated rice used as seed

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	-- Thousand metric tons --			Percent	Thousand metric tons		Percent
1960	104	--	--	--	--	--	--
1961	101	--	--	--	--	--	--
1962	98	--	--	--	--	--	--
1963	101	--	--	--	--	--	--
1964	101	--	--	--	--	--	--
1965	101	101	0	0.0	101	0	0.0
1966	103	101	2	1.9	102	1	1.0
1967	103	98	5	4.9	100	3	2.9
1968	104	100	4	3.8	100	4	3.8
1969	105	100	5	4.8	99	6	5.7
1970	99	96	3	3.0	94	5	5.1
1971	93	91	2	2.2	90	3	3.2
1972	94	88	6	6.4	89	5	5.3
1973	91	88	3	3.3	88	3	3.3
1974	93	88	5	5.4	88	5	5.4
1975	96	96	0	0.0	95	1	1.0
1976	98	100	-2	-2.0	100	-2	-2.0
1977	97	98	-1	-1.0	99	-2	-2.1
1978	92	92	0	0.0	93	-1	-1.1
1979	90	89	1	1.1	89	1	1.1
	Mean absolute value:		3	2.7		3	2.9
	Root mean square:		3	3.3		3	3.4

Note: Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 5.1 and model estimates.

Table 5.23--Actual and estimated wheat used as seed

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	- Thousand metric tons -			Percent	Thousand metric tons		Percent
1960	40	--	--	--	--	--	--
1961	43	--	--	--	--	--	--
1962	38	--	--	--	--	--	--
1963	31	--	--	--	--	--	--
1964	27	--	--	--	--	--	--
1965	26	51	-25	-96.2	51	-25	-96.2
1966	22	47	-25	-113.6	47	-25	-113.6
1967	24	45	-21	-87.5	47	-23	-95.8
1968	22	34	-12	-54.5	36	-14	-63.6
1969	17	26	-9	-52.9	26	-9	-52.9
1970	11	20	-9	-81.8	18	-7	-63.6
1971	9	13	-4	-44.4	14	-5	-55.6
1972	6	11	-5	-83.3	13	-7	-116.7
1973	5	8	-3	-60.0	9	-4	-80.0
1974	8	8	0	0.0	8	0	0.0
1975	9	11	-2	-22.2	10	-1	-11.1
1976	8	11	-3	-37.5	10	-2	-25.0
1977	10	10	0	0.0	9	1	10.0
1978	14	19	-5	-35.7	18	-4	-28.6
1979	21	18	3	14.3	18	3	14.3
	Mean absolute value:		8	52.3		9	55.1
	Root mean square:		12	62.3		12	66.9

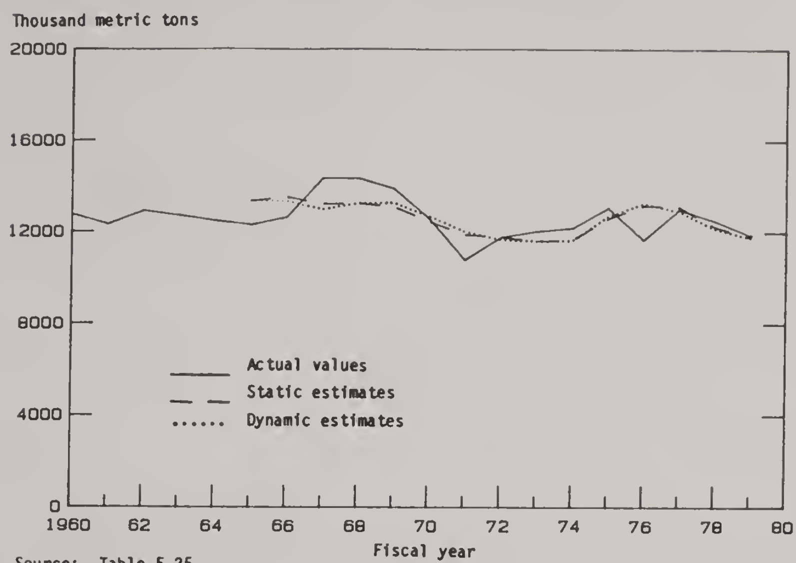
Sources: Table 5.1 and model estimates.

Table 5.24--Actual and estimated barley used as seed

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	- Thousand metric tons -			Percent	Thousand metric tons		Percent
1960	42	--	--	--	--	--	--
1961	37	--	--	--	--	--	--
1962	35	--	--	--	--	--	--
1963	27	--	--	--	--	--	--
1964	23	--	--	--	--	--	--
1965	20	32	-12	-60.0	32	-12	-60.0
1966	19	29	-10	-52.6	28	-9	-47.4
1967	22	29	-7	-31.8	28	-6	-27.3
1968	18	23	-5	-27.8	22	-4	-22.2
1969	14	17	-3	-21.4	16	-2	-14.3
1970	10	12	-2	-20.0	11	-1	-10.0
1971	8	9	-1	-12.5	9	-1	-12.5
1972	5	8	-3	-60.0	8	-3	-60.0
1973	5	6	-1	-20.0	6	-1	-20.0
1974	5	5	0	0.0	5	0	0.0
1975	6	6	0	0.0	6	0	0.0
1976	5	7	-2	-40.0	7	-2	40.0
1977	5	6	-1	-20.0	6	-1	-20.0
1978	8	11	-3	-37.5	12	-4	-50.0
1979	11	10	1	9.1	11	0	0.0
	Mean absolute value:		3	27.5		3	25.6
	Root mean square:		5	33.3		5	32.7

Sources: Table 5.1 and model estimates.

Figure 5.19
Actual and Estimated Japanese Rice Production Net of Seed Used



Source: Table 5.25

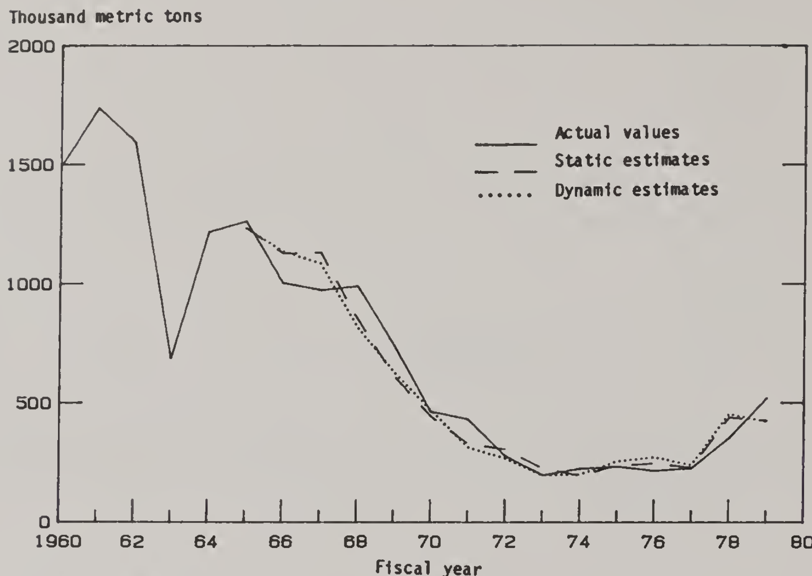
Table 5.25--Actual and estimated rice production net of seed used

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	12,754	--	--	--	--	--	--
1961	12,318	--	--	--	--	--	--
1962	12,911	--	--	--	--	--	--
1963	12,711	--	--	--	--	--	--
1964	12,483	--	--	--	--	--	--
1965	12,308	13,370	-1,062	-8.6	13,370	-1,062	-8.6
1966	12,642	13,342	-700	-5.5	13,520	-878	-6.9
1967	14,350	12,990	1,360	9.5	13,228	1,122	7.8
1968	14,345	13,272	1,073	7.5	13,255	1,090	7.6
1969	13,898	13,286	612	4.4	13,109	789	5.7
1970	12,590	12,701	-111	-0.9	12,471	119	0.9
1971	10,794	12,050	-1,256	-11.6	11,899	-1,105	-10.2
1972	11,795	11,691	104	0.9	11,792	3	0.0
1973	12,058	11,619	439	3.6	11,623	435	3.6
1974	12,199	11,645	554	4.5	11,681	518	4.2
1975	13,069	12,706	363	2.8	12,610	459	3.5
1976	11,674	13,283	-1,609	-13.8	13,171	-1,497	-12.8
1977	12,998	12,920	78	0.6	13,108	-110	-0.8
1978	12,497	12,173	324	2.6	12,249	248	2.0
1979	11,868	11,764	104	0.9	11,784	84	0.7
	Mean absolute value:		650	5.2		635	5.0
	Root mean square:		814	6.6		783	6.3

Note: Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Calculated from Table 5.1 and model estimates.

Figure 5.20
Actual and Estimated Japanese Wheat Production Net of Seed Used



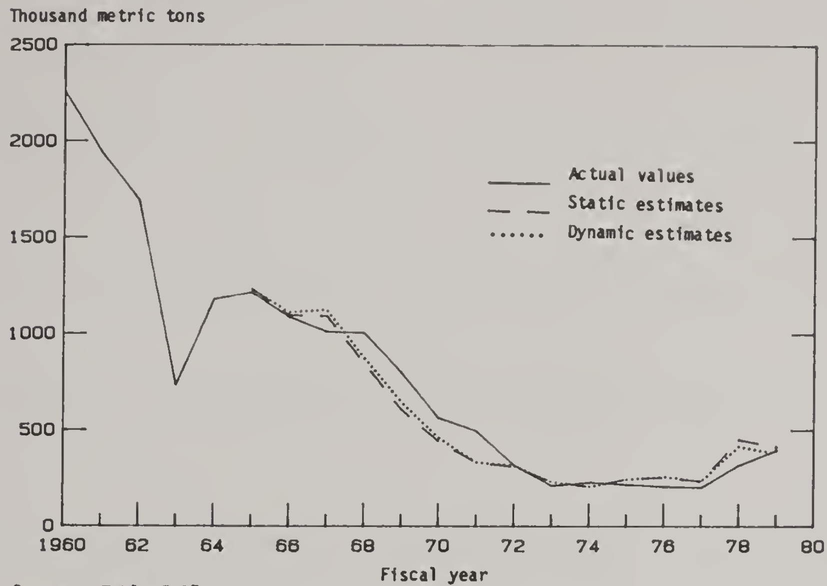
Source: Table 5.26

Table 5.26--Actual and estimated wheat production net of seed used

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	1,491	--	--	--	--	--	--
1961	1,738	--	--	--	--	--	--
1962	1,593	--	--	--	--	--	--
1963	685	--	--	--	--	--	--
1964	1,217	--	--	--	--	--	--
1965	1,261	1,232	29	2.3	1,232	29	2.3
1966	1,002	1,135	-133	-13.3	1,126	-124	-12.4
1967	973	1,085	-112	-11.5	1,130	-157	-16.1
1968	990	820	170	17.2	853	137	13.8
1969	741	631	110	14.8	614	127	17.1
1970	463	470	-7	-1.5	444	19	4.1
1971	431	314	117	27.1	330	101	23.4
1972	278	268	10	3.6	305	-27	-9.7
1973	197	197	0	0.0	226	-29	-14.7
1974	224	200	24	10.7	195	29	12.9
1975	232	255	-23	-9.9	238	-6	-2.6
1976	214	273	-59	-27.6	246	-32	-15.0
1977	226	239	-13	-5.8	228	-2	-0.9
1978	353	455	-102	-28.9	439	-86	-24.4
1979	520	422	98	18.8	426	94	18.1
	Mean absolute value:		67	12.9		67	12.5
	Root mean square:		86	15.9		84	14.4

Sources: Calculated from Table 5.1 and model estimates.

Figure 5.21
Actual and Estimated Japanese Barley Production Net of Seed Used



Source: Table 5.27

Table 5.27--Actual and estimated barley production net of seed used

Fiscal year	Actual value	Static estimation: Estimate	Static estimation: Residual	Static estimation: Residual / actual	Dynamic estimation: Estimate	Dynamic estimation: Residual	Dynamic estimation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	2,259	--	--	--	--	--	--
1961	1,939	--	--	--	--	--	--
1962	1,691	--	--	--	--	--	--
1963	732	--	--	--	--	--	--
1964	1,179	--	--	--	--	--	--
1965	1,214	1,232	-18	-1.5	1,232	-18	-1.5
1966	1,086	1,113	-27	-2.5	1,095	-9	-0.8
1967	1,010	1,126	-116	-11.5	1,092	-82	-8.1
1968	1,003	877	126	12.6	846	157	15.7
1969	798	647	151	18.9	607	191	23.9
1970	563	463	100	17.8	443	120	21.3
1971	495	335	160	32.3	333	162	32.7
1972	319	317	2	0.6	310	9	2.8
1973	211	232	-21	-10.0	233	-22	-10.4
1974	228	205	23	10.1	204	24	10.5
1975	215	244	-29	-13.5	247	-32	-14.9
1976	205	258	-53	-25.9	254	-49	-23.9
1977	201	235	-34	-16.9	234	-33	-16.4
1978	318	416	-98	-30.8	452	-134	-42.1
1979	396	383	13	3.3	415	-19	-4.8
	Mean absolute value:		65	13.9		71	15.3
	Root mean square:		83	17.0		94	19.1

Sources: Calculated from Table 5.1 and model estimates.

The regression results are converted into corn production net of seed used (rounded off to the nearest thousand metric tons), by means of the identity:

JPQPCNFY = ROUND(EXP(JPLQPCNF))

<u>where</u>:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

JPQPCNFY = Japan, corn production net of seed used, fiscal year (thousand metric tons)

JPLQPCNF = Japan, logarithm of corn production net of seed used, fiscal year (thousand metric tons)

Actual values are compared to their estimates in Table 5.28 and Figure 5.22. Since the corn equation does not involve lags, the distinction between static and dynamic estimation does not apply.

A regressed time trend is also used to estimate production net of seed used for other grain:

$$
\begin{array}{lcll}
\text{JPLQPOGF} & = & 232.147 & - \ 0.115527 * \text{YEAR} \\
 & & \pm\ 47.577 & \pm\ 0.024084 \\
 & & (4.879) & (4.797) \\
 & & 0.28\% & 0.30\%
\end{array}
$$

Adjusted R^2 = 75.87 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 1.318
Autocorrelation of residuals = 0.349

JPLQPOGF = Japan, logarithm of other grain production net of seed used, fiscal year (thousand metric tons)

YEAR = Japanese fiscal year (values from 1972 to 1979)

An identity converts the regression results into the implied production net of seed used for other grain, rounded off to the nearest thousand metric tons:

JPQPOGFY = ROUND(EXP(JPLQPOGF))

<u>where</u>:

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

JPQPOGFY = Japan, other grain production net of seed used, fiscal year (thousand metric tons)

JPLQPOGF = Japan, logarithm of other grain production net of seed used, fiscal year (thousand metric tons)

Estimated and actual values are shown in Table 5.29 and in Figure 5.23. Again, the distinction between static and dynamic estimation does not apply.

COMPENDIUM OF CROP REGRESSION EQUATIONS

Yields

Tables 5.30 to 5.32 list alternative yield equations for rice, wheat, and barley. In each case, the equation selected for the model is obviously the best choice.

Table 5.33 compares regression equations expressing yield as a function of the current supply price, the past year's supply price, the average of the current and past years' supply prices, or the average of the past 2 years' supply prices. For rice, no measure of the supply price bears a statistically significant relationship to yield. For wheat and for barley, the past year's supply price is confirmed to be the best predictor of yield.

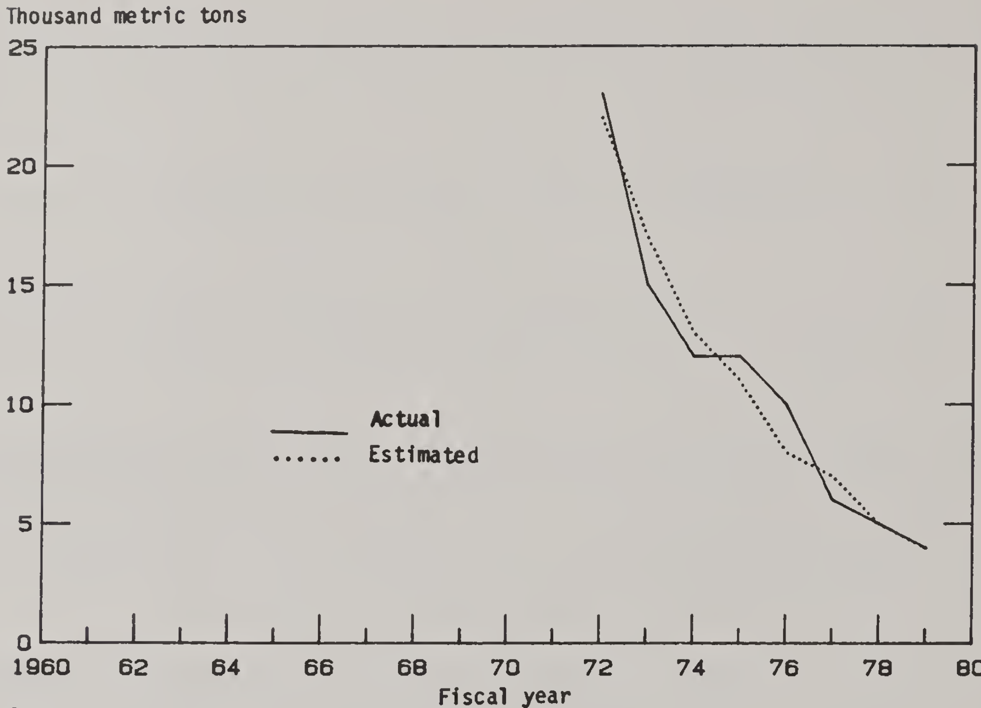
The next two tables concern the influence of fertilizer prices. Table 5.34 documents the cost of a 20-kilogram bag of urea. Table 5.35 shows the effects of adding a fertilizer price variable to the yield regression equations used in the model. For two out of three crops, the fertilizer price coefficients have the correct sign. However, the very small magnitudes and very weak significance levels of these coefficients indicate that the omission of fertilizer prices has a negligible effect on the model.

Areas

Table 5.36 displays regression equations for total area. Comparing these equations reveals several noteworthy items. Expected revenue from off-farm employment, as measured by lagged income per capita, clearly interacts with the effect of expected revenue from growing grain crops. Whenever the income coefficient is omitted from the regression equation, the coefficient for expected revenue from grains either is insignificant or has the wrong sign. Because population growth almost follows a time trend, population and year variables never appear together in a regression equation. By comparing pairs of equations identical except that one includes population and the other includes a time trend, one can see that the population variable consistently has more explanatory power than a time trend. Thus the equation which includes population always has the higher adjusted R^2 statistic, and the t-statistic for population always has a greater absolute value than the corresponding t-statistic for year.

--Text continues to page 169.

Figure 5.22
Actual and Estimated Japanese Corn
Production Net of Seed Used



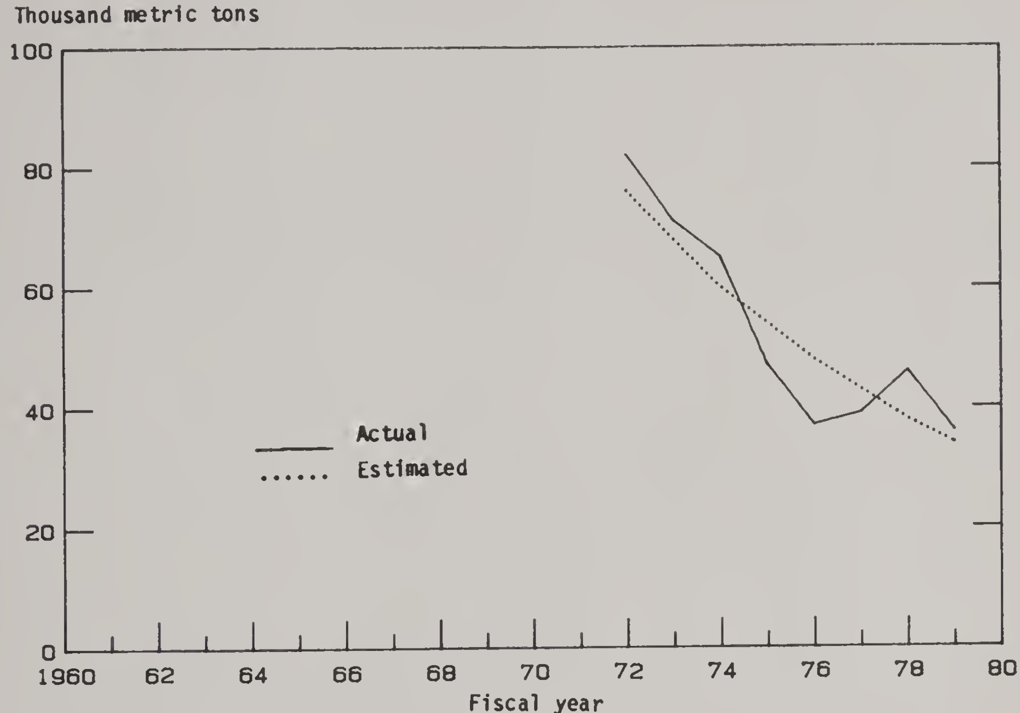
Source: Table 5.28

Table 5.28--Actual and estimated corn production net of seed used

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1972	23	22	1	4.3
1973	15	17	-2	-13.3
1974	12	13	-1	-8.3
1975	12	11	1	8.3
1976	10	8	2	20.0
1977	6	7	-1	-16.7
1978	5	5	0	0.0
1979	4	4	0	0.0
		Mean absolute value:	1	8.9
		Root mean square:	1	11.3

Sources: Calculated from Table 5.1 and model estimates.

Figure 5.23
Actual and Estimated Japanese Other Coarse Grain Production Net of Seed Used



Source: Table 5.29

Table 5.29--Actual and estimated other grain production net of seed used

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1972	82	76	6	7.3
1973	71	68	3	4.2
1974	65	60	5	7.7
1975	47	54	-7	-14.9
1976	37	48	-11	-29.7
1977	39	43	-4	-10.3
1978	46	38	8	17.4
1979	36	34	2	5.6
		Mean absolute value:	6	12.1
		Root mean square:	6	14.5

Sources: Calculated from Table 5.1 and model estimates.

Table 5.30--Regression equations for rice yield

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSRI1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHARI	Comments
58.51% 2.053 -.076	-25 $\pm$ 6 (4.3) 0.09%	0.013 $\pm$ .003 (4.6) 0.05%				EQUATION USED IN MODEL.
-6.69% 0.833 .415	0.7 $\pm$ 2.1 (0.35) 73%		0.15 $\pm$ .43 (0.35) 73%			Insignificant $\overline{R}^2$ and coefficient for price.
0.50% 0.951 .385	1.46 $\pm$ 0.03 (45) 0.01%			-0.059 $\pm$ .057 (1.0) 32%		Poor $\overline{R}^2$ and coefficient for diversion payment.
36.23% 1.505 .166	5.3 $\pm$ 1.3 (4.2) 0.11%				-0.48 $\pm$ .16 (3.0) 1.0%	Weak $\overline{R}^2$.
56.83% 2.110 -.087	-26 $\pm$ 6 (4.3) 0.11%	0.013 $\pm$ .003 (4.5) 0.07%	0.19 $\pm$ .27 (0.70) 49%			Poor coefficient for price.
55.51% 2.057 -.085	-26 $\pm$ 7 (3.9) 0.21%	0.014 $\pm$ .003 (4.1) 0.14%		0.015 $\pm$ .042 (0.35) 73%		Wrong sign for diversion payment.
55.94% 2.089 -.092	-31 $\pm$ 14 (2.2) 4.6%	0.016 $\pm$ .006 (2.6) 2.3%			0.13 $\pm$ .27 (0.49) 63%	Wrong sign for area.
-3.53% 0.971 .394	-0.1 $\pm$ 2.2 (0.04) 97%		0.31 $\pm$ .45 (0.70) 50%	-0.073 $\pm$ .062 (1.2) 26%		Insignif. $\overline{R}^2$ and coeff. for price, poor coeff. for diversion payment.
48.90% 1.885 .036	3.0 $\pm$ 1.6 (1.9) 8.0%		0.67 $\pm$ .33 (2.1) 6.2%		-0.61 $\pm$ 0.16 (3.9) 0.21%	Weak $\overline{R}^2$.
39.32% 1.657 .055	7.0 $\pm$ 1.8 (3.9) 0.23%			0.084 $\pm$ .065 (1.3) 22%	-0.69 $\pm$ .23 (3.1) 1.0%	Wrong sign for diversion payment, weak $\overline{R}^2$.
52.98% 2.109 -.090	-26 $\pm$ 7 (3.8) 0.27%	0.014 $\pm$ .003 (3.9) 0.24%	0.18 $\pm$ .30 (0.60) 56%	0.006 $\pm$ .046 (0.13) 90%		Wrong sign for diversion payment, insignificant coeff. for price.
52.93% 2.110 -.086	-25 $\pm$ 19 (1.3) 23%	0.013 $\pm$ .009 (1.4) 18%	0.22 $\pm$ .45 (0.48) 64%		-0.03 $\pm$ .44 (0.07) 95%	Insignificant coeff. for price and area, weak coeff. for time.
51.95% 2.069 -.063	-32 $\pm$ 19 (1.7) 12%	0.016 $\pm$ .008 (2.0) 6.6%		-0.004 $\pm$ .072 (0.06) 95%	0.15 $\pm$ .46 (0.34) 74%	Wrong sign for area, insignificant coefficient for diversion payment.

(Continues to next page)

(Table 5.30, continued)

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSRI1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHARI	Comments
52.84% 2.153 -.116	4.7 ± 1.9 (2.4) 3.3%		0.66 ± .31 (2.1) 5.9%	0.081 ± .057 (1.4) 18%	-0.81 ± .21 (3.9) 0.24%	Wrong sign for diversion payment.
49.04% 2.122 -.098	-12 ± 38 (0.30) 77%	0.007 ± .017 (0.42) 68%	0.41 ± .67 (0.61) 56%	0.04 ± .11 (0.40) 70%	-0.4 ± 1.0 (0.39) 71%	Wrong sign for diversion payment, insig. coeff. for price and area.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)

Independent variables: JPLPSRI1 = Japan, logarithm of rice supply price during previous fiscal year (1970 yen per kilogram)

JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)

JPLHARI = Japan, logarithm of rice area planted (thousand hectares)

YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.31--Regression equations for wheat yield

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSWH1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHAWH	Comments
13.32% 1.326 .222	-25 ± 14 (1.7) 11%	0.013 ± .007 (1.8) 9.9%				Poor $\bar{R}^2$.
50.29% 2.146 -.090	-2.9 ± 1.0 (2.9) 1.2%		0.96 ± .25 (3.9) 0.18%			EQUATION USED IN MODEL.
-2.98% 1.076 .276	1.04 ± 0.06 (18) 0.01%			0.08 ± .10 (0.77) 45%		Wrong sign for diversion payment, insignificant $\bar{R}^2$.
-6.05% 1.115 .273	1.1 ± 0.3 (4.0) 0.16%				-0.025 ± .055 (0.45) 66%	Insignificant $\bar{R}^2$ and coefficient for area.
47.51% 2.157 -.096	-10 ± 12 (0.80) 44%	0.0036 ± .0065 (0.56) 59%	0.88 ± .29 (3.1) 0.96%			Insignificant coefficient for time, weak $\bar{R}^2$.
28.46% 1.549 .130	-37 ± 15 (2.5) 2.7%	0.019 ± .007 (2.6) 2.4%		0.18 ± .09 (1.9) 7.7%		Wrong sign for diversion payment, weak $\bar{R}^2$.
31.27% 1.779 .087	-68 ± 24 (2.8) 1.6%	0.035 ± .012 (2.8) 1.5%			0.17 ± .08 (2.1) 5.8%	Wrong sign for area, weak $\bar{R}^2$.
48.91% 2.114 -.080	-2.8 ± 1.0 (2.8) 1.7%		0.94 ± .25 (3.8) 0.27%	0.058 ± .072 (0.81) 44%		Wrong sign for diversion payment, weak $\bar{R}^2$.
47.89% 2.199 -.120	-2.8 ± 1.1 (2.7) 2.1%		0.96 ± .25 (3.8) 0.25%		-0.024 ± .039 (.63) 54%	Insignificant coefficient for area, weak $\bar{R}^2$.
-0.35% 1.191 .208	1.5 ± 0.4 (3.9) 0.22%			0.17 ± .13 (1.3) 21%	-0.077 ± .067 (1.2) 27%	Wrong sign for diversion payment, insignif. $\bar{R}^2$, poor coeff. for area.
50.52% 2.172 -.103	-19 ± 14 (1.4) 19%	0.0087 ± .0074 (1.2) 26%	0.75 ± .30 (2.5) 2.9%	0.11 ± .08 (1.3) 22%		Wrong sign for diversion payment, poor coefficient for time.
43.26% 2.238 -.141	4 ± 44 (0.08) 94%	-0.003 ± .023 (0.15) 89%	1.0 ± 0.5 (1.9) 8.7%		-0.04 ± .14 (0.32) 76%	Wrong sign for time, insignificant coefficient for area, weak $\bar{R}^2$.
32.33% 1.796 .071	-63 ± 25 (2.5) 2.7%	0.032 ± .012 (2.6) 2.4%		0.11 ± 0.10 (1.1) 30%	0.12 ± .09 (1.3) 22%	Wrong sign for diversion payment and area, weak $\bar{R}^2$.

(Continues to next page)

(Table 5.31, continued)

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSWH1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHAWH	Comments
53.43% 2.303 -.179	2.4 $\pm$ 1.0 (2.3) 4.2%		0.92 $\pm$ .24 (3.9) 0.27%	0.13 $\pm$ .09 (1.6) 15%	-0.067 $\pm$ .046 (1.5) 17%	Wrong sign for diversion payment, weak coefficient for area.
49.98% 2.484 -.283	18 $\pm$ 42 (0.44) 67%	-0.011 $\pm$ .022 (0.49) 63%	1.1 $\pm$ 0.5 (2.2) 5.2%	0.14 $\pm$ .09 (1.6) 15%	-0.13 $\pm$ .14 (0.94) 37%	Wrong sign for diversion payment, insignificant coefficient for time, weak $\overline{R}^2$ and coefficient for area.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLYDWH = Japan, logarithm of wheat yield (metric tons per hectare)

Independent variables:
JPLPSWH1 = Japan, logarithm of wheat supply price during previous fiscal year (1970 yen per kilogram)
JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)
JPLHAWH = Japan, logarithm of wheat area planted (thousand hectares)
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.32--Regression equations for barley yield

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSBA1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHABA	Comments
-3.52% 1.467 .155	-7 ± 11 (0.63) 54%	0.0042 ± .0058 (0.72) 48%				Insignificant $\overline{R}^2$, poor coefficient for time.
53.53% 2.296 -.155	-1.5 ± 0.6 (2.4) 3.3%		0.64 ± .15 (4.1) 0.12%			EQUATION USED IN MODEL.
-3.68% 1.458 .117	1.09 ± 0.04 (26) 0.01%			0.052 ± .074 (0.71) 49%		Wrong sign for diversion payment, insignificant $\overline{R}^2$.
-6.84% 1.421 .139	1.0 ± 0.2 (5.0) 0.03%				0.013 ± .040 (0.32) 75%	Wrong sign for area, insignificant $\overline{R}^2$.
54.05% 2.520 -.271	7.5 ± 8.4 (0.90) 39%	-0.0047 ± .0044 (1.1) 31%	0.73 ± .17 (4.2) 0.13%			Wrong sign for time.
-1.29% 1.595 .107	-13 ± 12 (1.1) 31%	0.0072 ± .0063 (1.1) 28%		0.091 ± .081 (1.1) 28%		Wrong sign for diversion payment, insignif. $\overline{R}^2$, poor coeff. for time.
27.79% 2.096 -.063	-57 ± 21 (2.6) 2.1%	0.029 ± .011 (2.7) 2.0%			0.19 ± .07 (2.6) 2.4%	Wrong sign for area, weak $\overline{R}^2$.
52.22% 2.347 -.180	-1.4 ± 0.6 (2.3) 4.3%		0.63 ± .16 (4.0) 0.17%	0.040 ± .050 (0.80) 44%		Wrong sign for diversion payment.
52.94% 2.458 -.235	-1.6 ± 0.6 (2.5) 2.6%		0.65 ± .16 (4.2) 0.13%		0.024 ± .026 (0.92) 38%	Wrong sign for area.
-12.28% 1.461 .117	1.1 ± 0.3 (4.1) 0.15%			0.056 ± .092 (0.61) 55%	-0.003 ± .048 (0.07) 95%	Wrong sign for diversion payment, insignif. $\overline{R}^2$ and coeff. for area.
50.27% 2.497 -.261	6 ± 10 (0.59) 57%	-0.0039 ± .0054 (0.73) 48%	0.71 ± .19 (3.7) 0.37%	0.018 ± .060 (0.30) 77%		Wrong sign for year and diversion payment.
50.70% 2.606 -.321	22 ± 36 (0.63) 54%	-0.012 ± .018 (0.67) 51%	0.85 ± .33 (2.6) 2.6%		-0.05 ± .11 (0.43) 68%	Wrong sign for time, insignificant coefficient for area.
21.89% 2.095 -.063	-56 ± 23 (2.5) 3.2%	0.028 ± .011 (2.5) 3.0%		0.024 ± .078 (0.31) 77%	0.18 ± .08 (2.1) 5.6%	Wrong sign for diversion payment and area, poor $\overline{R}^2$.

(Continues to next page)

(Table 5.32, continued)

Regression statistics	Intercept	Time trend YEAR	ln(Price during previous year) JPLPSBA1	Diversion payment log-ratio measure JPLXRDP	ln(Area) JPLHABA	Comments
49.22% 2.439 -.227	-1.6 ± 0.7 (2.2) 4.8%		0.64 ± .16 (3.9) 0.23%	0.022 ± .062 (0.35) 73%	0.018 ± .033 (0.54) 60%	Wrong sign for diversion payment and area, weak $\overline{R}^2$.
46.63% 2.588 -.317	24 ± 37 (0.64) 54%	-0.013 ± .019 (0.68) 51%	0.85 ± .34 (2.5) 3.3%	0.026 ± .064 (0.40) 70%	-0.06 ± .12 (0.50) 63%	Wrong sign for time and diversion payment, insignificant coefficient for area, weak $\overline{R}^2$.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLYDBA = Japan, logarithm of barley yield (metric tons per hectare)

Independent variables: JPLPSBA1 = Japan, logarithm of barley supply price during previous fiscal year (1970 yen per kilogram)

JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)

JPLHABA = Japan, logarithm of barley area planted (thousand hectares)

YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.33--The effect of alternative lag specifications on regression equations for yield

Dependent variable	Definition of the supply price variable	Adjusted R^2 statistic	Price coefficient ± Standard error	(t-statistic)	Significance level
ln(Rice yield)	ln(Price current year)	-7.25%	-0.10 ± .41	(0.23)	82%
	ln(Price average, current and past year)	-7.67%	0.03 ± .47	(0.06)	96%
	ln(Price one year ago)	-6.69%	0.15 ± .43	(0.35)	73%
	ln(Price average, one and two years ago)	-2.58%	0.33 ± .41	(0.81)	44%
ln(Wheat yield)	ln(Price current year)	35.48%	0.73 ± .25	(2.9)	1.1%
	ln(Price average, current and past year)	49.48%	0.95 ± .25	(3.8)	0.21%
	ln(Price one year ago)	50.29%	0.96 ± .25	(3.9)	0.18%
	ln(Price average, one and two years ago)	47.64%	1.17 ± 0.31	(3.7)	0.26%
ln(Barley yield)	ln(Price current year)	17.31%	0.36 ± .18	(2.0)	6.9%
	ln(Price average, current and past year)	36.56%	0.54 ± .18	(3.0)	1.0%
	ln(Price one year ago)	53.53%	0.64 ± .15	(4.1)	0.12%
	ln(Price average, one and two years ago)	49.61%	0.76 ± .20	(3.8)	0.20%

Notes: Regression equations include coefficients not listed in this table.
Each t-statistic is expressed in terms of its absolute value.

Source: Model estimates.

Table 5.34--Fertilizer prices

Fiscal year	Price of urea fertilizer in a twenty-kilogram bag	
	Current yen per kilogram	1970 yen per kilogram
1960	40.85	71.0763
1961	40.30	66.0051
1962	39.90	61.2409
1963	39.60	57.0436
1964	39.55	54.3801
1965	39.45	50.9522
1966	39.35	48.5755
1967	38.85	46.0111
1968	37.75	42.6313
1969	36.95	39.1583
1970	36.30	36.3000
1971	35.45	33.2607
1972	35.00	31.2122
1973	36.30	27.8724
1974	46.95	29.5891
1975	53.00	30.2250
1976	55.40	28.9091
1977	58.55	28.6321
1978	58.50	27.6571
1979	60.35	27.2298

Sources:

Price in current yen:

Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, page 229 in the 1979/80 edition and the equivalent table in earlier editions, converted from yen per bag into yen per kilogram.

Price in 1970 yen:

The current-yen statistics in this table, divided by the fiscal-year Consumer Price Index from Table 2.9 (readjusted so that 1970 = 1).

Table 5.35--Regression equations for yield including the price of fertilizer as an explanatory variable

Dependent variable	Regression statistics	Intercept	ln(Fertilizer price) JPLPDURF	ln(Crop price in previous year) JPLPSWH1, JPLPSBA1	Time trend YEAR	Comments
ln(Rice yield)	55.14% 2.063 -.077	-22 $\pm$ 19 (1.2) 26%	-0.03 $\pm$ .18 (0.15) 88%		0.012 $\pm$ .009 (1.3) 21%	Insignificant coeff. for fertilizer price, weak coefficient for time.
ln(Wheat yield)	47.12% 2.164 -.099	-2.6 $\pm$ 1.3 (2.1) 6.2%	-0.06 $\pm$ .12 (0.47) 65%	0.93 $\pm$ .26 (3.5) 0.43%		Insignificant coefficient for fertilizer price, weak $\overline{R}^2$.
ln(Barley yield)	53.41% 2.463 -.241	-1.9 $\pm$ 0.8 (2.5) 2.9%	0.081 $\pm$ .082 (0.98) 35%	0.68 $\pm$ .16 (4.2) 0.11%		Wrong sign for fertilizer price.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variables: JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)
JPLYDWH = Japan, logarithm of wheat yield (metric tons per hectare)
JPLYDBA = Japan, logarithm of barley yield (metric tons per hectare)

Independent variables: JPLPDURF = Japan, logarithm of urea fertilizer price, fiscal year (1970 yen per kilogram)
JPLPSWH1 = Japan, logarithm of wheat supply price during previous fiscal year (1970 yen per kilogram)
JPLPSBA1 = Japan, logarithm of barley supply price during previous fiscal year (1970 yen per kilogram)
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Tables 5.37 through 5.39 describe regressions used to split the rice area from the nonrice area, to split the wheat plus barley area from the other nonrice area, and to split the wheat area from the barley area. Table 5.37 points to one equation as the obvious best choice to separate the rice and nonrice areas. The best choice of equation to separate wheat and barley from the other nonrice area is less clear (Table 5.38). Perhaps the diversion payment should be included as an explanatory variable. It is not, because the coefficient for that variable is highly unstable across different specifications of the regression equation; and also because it seems incorrect to include the diversion payment in the equation splitting wheat and barley from other nonrice, when the diversion payment is excluded from the equation splitting rice from nonrice. Table 5.38 also demonstrates the interaction between the coefficients for lagged income per capita and for expected revenue from wheat and barley. This is similar to the interaction between lagged income and expected revenue previously found in regressions for the total area planted. Table 5.39 indicates that better estimates of the ratio of the wheat area to the barley area can be obtained by including both the expected revenue from wheat and the expected revenue from barley as explanatory variables, instead of just including the ratio of expected revenues. But after both regression equations are transformed into the implied wheat and barley areas, the difference in their accuracy practically disappears. Therefore the simpler equation is adopted. Using the ratio of expected revenues as the explanatory variable also fits in better with the model of Japanese policies presented in Chapter Seven. Finally, it is surprising that the diversion payment apparently has no significant influence on area allocations, particularly the division of land between rice and nonrice. Perhaps the diversion payment really is significant, while the log-ratio measure of it developed here does not represent it well. Other measures of the diversion payment (not reported here) were tried, and they also failed to show a statistically significant influence.

The model assumes that expected revenue equals last year's supply price times the average of the last 3 years' yields. Table 5.40 presents summary statistics on what happens when different lag structures are specified for expected revenue. The table shows that the optimal lag structure varies with the subject of the regression equation. The lag structure used in the model appears to be a reasonable compromise choice to apply uniformly across all area equations.

Seed Used

Table 5.41 summarizes regressions of seed usage rates on time. Wheat and barley seed usage rates both have statistically significant time trends; the rice seed usage rate does not. As mentioned previously, the quantities of wheat and barley used as seed are so minuscule that it was not considered worthwhile to incorporate these time trends into the model.

Table 5.36--Regression equations for the total area planted

Regression statistics	Intercept	ln(Expected revenue from grains) JPLXRTG	Diversion payment log-ratio measure JPLXRDP	ln(Population) JPLPOPFY	ln(Income/capita, previous year) JPLGNPF1	Comments
85.95% 0.323 .759	29 ± 2 (13) 0.01%			-1.7 ± 0.2 (9.3) 0.01%		
95.89% 0.938 .490	11.5 ± 0.2 (76) 0.01%				-0.42 ± .02 (18) 0.01%	
96.26% 0.967 .449	15 ± 2 (6.2) 0.01%			-0.37 ± .24 (1.5) 16%	-0.34 ± .06 (6.1) 0.01%	Weak coefficient for population.
59.65% 0.545 .716	12.8 ± 0.9 (15) 0.01%	-0.65 ± .14 (4.7) 0.04%				Wrong sign for expected revenue.
84.78% 0.320 .758	29 ± 3 (8.5) 0.01%	0.007 ± .164 (0.04) 97%		-1.7 ± 0.4 (4.7) 0.05%		Insignificant coefficient for expected revenue.
96.22% 1.050 .436	11.1 ± 0.3 (35) 0.01%	0.12 ± .08 (1.5) 17%			-0.47 ± .04 (11) 0.01%	Weak coefficient for expected revenue.
97.45% 1.378 .159	16 ± 2 (7.9) 0.01%	0.18 ± .07 (2.6) 2.6%		-0.55 ± .21 (2.6) 2.5%	-0.38 ± .05 (7.8) 0.01%	EQUATION USED IN MODEL.
77.64% 0.566 .693	12.0 ± 0.7 (17) 0.01%	-0.51 ± .11 (4.5) 0.07%	0.14 ± .04 (3.4) 0.54%			Wrong sign for expected revenue.
97.03% 0.953 .386	26 ± 2 (17) 0.01%	0.021 ± .072 (0.28) 78%	0.11 ± .02 (7.1) 0.01%	-1.5 ± 0.2 (8.9) 0.01%		Insignificant coefficient for expected revenue.
96.03% 1.233 0.333	11.1 ± 0.3 (34) 0.01%	0.16 ± .10 (1.5) 15%	-0.017 ± .027 (0.64) 54%		-0.51 ± .07 (7.5) 0.01%	Insig. coeff. for diversn. payment, weak coeff. for expected revenue.
97.84% 1.166 .235	20 ± 3 (7.1) 0.01%	0.12 ± .07 (1.6) 15%	0.050 ± .029 (1.7) 11%	-0.91 ± .28 (3.2) 0.94%	-0.23 ± .10 (2.3) 4.7%	Weak coefficient for expected revenue and diversion payment.

(Continues to next page)

(Table 5.36, continued)

Regression statistics	Intercept	ln(Expected revenue from grains) JPLXRTG	Diversion payment log-ratio measure JPLXRDP	Time trend YEAR	ln(Income/capita, previous year) JPLGNPF1	Comments
83.33% 0.296 .765	52 ± 5 (10) 0.01%			−0.022 ± .003 (8.4) 0.01%		
95.89% 0.944 .463	17 ± 6 (2.9) 1.2%			−0.0032 ± .0032 (1.0) 34%	−0.37 ± .06 (6.4) 0.01%	Poor coefficient for time.
81.95% 0.294 .764	52 ± 9 (5.5) 0.01%	0.006 ± .185 (0.03) 97%		−0.022 ± .005 (4.1) 0.14%		Insignificant coefficient for expected revenue.
96.98% 1.273 .216	22 ± 5 (4.0) 0.20%	0.18 ± .08 (2.3) 4.1%		−0.0060 ± .0030 (2.0) 7.1%	−0.40 ± .05 (7.8) 0.01%	
94.52% 0.654 .553	45 ± 5 (8.4) 0.01%	0.02 ± .10 (0.16) 88%	0.11 ± .02 (5.3) 0.02%	−0.018 ± .003 (6.2) 0.01%		Insignificant coefficient for expected revenue.
96.87% 1.098 .291	26 ± 7 (3.5) 0.60%	0.15 ± .09 (1.7) 12%	0.025 ± .032 (0.79) 45%	−0.0081 ± .0041 (2.0) 7.4%	−0.33 ± .11 (3.0) 1.2%	Poor coeff. for diversion payment, weak coeff. for expected revenue.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLHATG = Japan, logarithm of gross area planted to all crops (thousand hectares)

Independent variables:
JPLXRTG = Japan, logarithm of average expected revenue from grains (thousands of 1970 yen per hectare)
JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)
JPLPOPFY = Japan, logarithm of population on October 1 (thousands)
JPLGNPF1 = Japan, logarithm of gross national product during previous fiscal year (thousands of 1970 yen per capita)
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.37--Regression equations to split the rice area from the nonrice area

Regression statistics	Intercept	ln(Expected revenue from rice) JPLXRRI	ln(Expct.rev.from wheat and barley) JPLXRWB	Diveraion payment log-ratio measure JPLXRDP	ln(Income/capita, previous year) JPLGNPF1	Comments
-7.69% 0.687 .508	$-0.15 \pm .03$ (5.3) 0.01%			$0.0004 \pm .0504$ (0.007) 99%		Insignificant $\overline{R}^2$ and coefficient for diversion payment.
5.99% 0.790 .455	$-0.76 \pm .44$ (1.7) 11%				$0.093 \pm .068$ (1.4) 19%	Wrong sign for income, poor $\overline{R}^2$.
12.23% 0.705 .427	-1.3 ± 0.6 (2.3) 4.4%			$0.088 \pm .063$ (1.4) 19%	$0.18 \pm .09$ (2.0) 7.0%	Wrong aign for income, poor $\overline{R}^2$, weak coeff. for diversion payment.
36.97% 0.836 .388	-3.3 ± 1.0 (3.2) 0.72%	$0.49 \pm .16$ (3.0) 0.96%				Weak $\overline{R}^2$.
34.33% 0.792 .393	-3.4 ± 1.1 (3.2) 0.77%	$0.51 \pm .17$ (3.1) 1.0%		$0.028 \pm .040$ (0.69) 50%		Insignificant coefficient for diversion payment, weak $\overline{R}^2$.
32.55% 0.844 .390	-3.4 ± 1.1 (3.0) 1.1%	$0.54 \pm .22$ (2.5) 2.9%			$-0.029 \pm .075$ (0.38) 71%	Insignificant coefficient for income, weak $\overline{R}^2$.
28.57% 0.744 .392	-3.3 ± 1.2 (2.8) 1.6%	$0.48 \pm .25$ (1.9) 7.9%		$0.036 \pm .063$ (0.58) 58%	$0.02 \pm .12$ (0.18) 86%	Wrong sign for income, insignif. coeff. for divsn. payment, weak $\overline{R}^2$.
70.76% 1.368 .223	-4.2 ± 0.7 (5.7) 0.01%	$0.90 \pm .15$ (6.0) 0.01%	$-0.34 \pm .08$ (4.0) 0.18%			EQUATION USED IN MODEL.
69.14% 1.357 .205	-4.3 ± 0.8 (5.6) 0.02%	$0.91 \pm .15$ (5.9) 0.01%	$-0.33 \pm .09$ (3.8) 0.29%	$0.017 \pm .028$ (0.61) 56%		Insignificant coefficient for diversion payment.
68.42% 1.356 .237	-4.1 ± 0.8 (5.1) 0.03%	$0.87 \pm .17$ (5.0) 0.04%	$-0.35 \pm .09$ (3.8) 0.28%		$0.018 \pm .053$ (0.33) 75%	Wrong sign for income.
70.29% 1.302 .220	-4.0 ± 0.8 (5.1) 0.04%	$0.79 \pm .18$ (4.5) 0.12%	$-0.36 \pm .09$ (4.1) 0.23%	$0.053 \pm .041$ (1.3) 22%	$0.092 \pm .077$ (1.2) 26%	Wrong sign for income, weak coefficient for diversion payment.

Regression statistics	Intercept	Time trend YEAR	Comments
0.09% 0.743 .461	-7.7 ± 7.5 (1.0) 32%	$0.0038 \pm .0038$ (1.0) 33%	Poor $\overline{R}^2$ and coefficient for time.

(Continues to next page)

(Table 5.37, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLHRINR = Japan, logarithm of ratio: (rice area) / (nonrice area)

Independent variables:
- JPLXRRI = Japan, logarithm of rice expected revenue (thousands of 1970 yen per hectare)
- JPLXRWB = Japan, logarithm of average expected revenue from wheat and barley (thousands of 1970 yen per hectare)
- JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)
- JPLGNPF1 = Japan, logarithm of gross national product during previous fiscal year (thousands of 1970 yen per capita)
- YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.38--Regression equations to split the wheat and barley area from the other nonrice area

Regression statistics	Intercept	ln(Expct.rev.from wheat and barley) JPLXRWB	Diversion payment log-ratio measure JPLXRDP	ln(Income/capita, previous year) JPLGNPF1	Comments
83.79% 0.561 .603	13 ± 2 (7.3) 0.01%			-2.3 ± 0.3 (8.6) 0.01%	
27.37% 0.254 .840	-1.8 ± 0.2 (7.8) 0.01%		1.0 ± 0.4 (2.5) 2.6%		Weak $\overline{R}^2$.
83.55% 0.591 .553	14 ± 2 (6.0) 0.01%		-0.24 ± .26 (0.90) 39%	-2.5 ± 0.4 (6.7) 0.01%	Poor coefficient for diversion payment.
1.40% 0.214 .845	-3.8 ± 5.5 (0.69) 50%	-1.2 ± 1.1 (1.1) 29%			Wrong sign for expected revenue, poor $\overline{R}^2$.
92.25% 0.770 .607	8.8 ± 1.6 (5.5) 0.01%	1.5 ± 0.4 (3.9) 0.21%		-2.8 ± 0.2 (12) 0.01%	EQUATION USED IN MODEL.
24.51% 0.327 .818	1.7 ± 4.9 (0.35) 73%	-0.70 ± .98 (0.71) 49%	0.93 ± .42 (2.2) 4.6%		Wrong sign for expected revenue, poor $\overline{R}^2$.
96.14% 2.084 -.066	11 ± 1 (8.6) 0.01%	1.7 ± 0.3 (6.3) 0.01%	-0.48 ± .13 (3.6) 0.40%	-3.4 ± 0.2 (15) 0.01%	

Regression statistics	Intercept	Time trend YEAR	Comments
72.32% 0.365 .658	232 ± 38 (6.1) 0.01%	-0.12 ± .02 (6.1) 0.01%	

(Continues to next page)

(Table 5.38, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLHWBON = Japan, logarithm of ratio: (wheat plus barley area) / (other nonrice area)

Independent variables:
JPLXRWB = Japan, logarithm of average expected revenue from wheat and barley (thousands of 1970 yen per hectare)
JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)
JPLGNPF1 = Japan, logarithm of gross national product during previous fiscal year (thousands of 1970 yen per capita)
YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.39--Regression equations to split the wheat area from the barley area

Regression statistics	Intercept	ln(Expected revenue from wheat) JPLXRWH	ln(Expected revenue from barley) JPLXRBA	ln(Expected rev.: wheat/barley) JPLRWHBA	Diversion payment log-ratio measure JPLXRDP	Comments
62.78% 0.901 .271	-0.053 ± .027 (1.9) 7.4%			2.2 ± 0.4 (5.0) 0.03%		EQUATION USED IN MODEL.
60.24% 0.869 .280	-0.041 ± .041 (1.0) 34%			2.1 ± 0.5 (4.3) 0.10%	0.018 ± .043 (0.41) 69%	Insignificant coefficient for diversion payment.
67.97% 0.966 .276	-0.82 ± .44 (1.9) 8.4%	2.1 ± 0.4 (5.0) 0.03%	-1.9 ± 0.4 (4.4) 0.09%			
69.18% 0.970 .289	-1.0 ± 0.5 (2.2) 5.0%	1.9 ± 0.5 (4.0) 0.20%	-1.7 ± 0.5 (3.3) 0.66%		0.050 ± .041 (1.2) 25%	Poor coefficient for diversion payment.

Regression statistics	Intercept	Time trend YEAR	Comments
14.50% 0.583 .521	-17 ± 9 (1.8) 9.0%	0.085 ± .0046 (1.8) 8.9%	Poor $\overline{R}^2$.

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLHWHBA = Japan, logarithm of ratio: (wheat area) / (barley area)

Independent variables:
- JPLXRWH = Japan, logarithm of wheat expected revenue (thousands of 1970 yen per hectare)
- JPLXRBA = Japan, logarithm of barley expected revenue (thousands of 1970 yen per hectare)
- JPLRWHBA = Japan, logarithm of ratio: (wheat expected revenue) / (barley expected revenue)
- JPLXRDP = Japan, logarithm of ratio: (rice expected revenue minus rice diversion payment) / (rice expected revenue)
- YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 5.40--The effect of alternative lag specifications on regression equations for areas

Part A: Regression equations for the total area planted

Price used to calculate expected revenue	Yield used to calculate expected revenue	Adjusted R^2 statistic	ln(Expected revenue from grains)		
			Coefficient ± Standard error	(t-statistic)	Significance level
Price during past year	Average yield, past 2 years	98.37%	0.21 ± .05	(4.1)	0.19%
	Average yield, past 3 years	97.45%	0.18 ± .07	(2.6)	2.6%
	Average yield, past 4 years	97.32%	0.20 ± .08	(2.4)	3.5%
Average price, past 2 years	Average yield, past 2 years	98.40%	0.22 ± .05	(4.1)	0.17%
	Average yield, past 3 years	97.42%	0.18 ± .07	(2.5)	2.8%
	Average yield, past 4 years	97.20%	0.19 ± .09	(2.2)	4.7%

Part B: Regression equations to split the rice area from the nonrice area

Price used to calculate expected revenue	Yield used to calculate expected revenue	Adjusted R^2 statistic	ln(Expected revenue from rice)			ln(Expected revenue from wheat and barley)		
			Coefficient ± Standard error	(t-statistic)	Significance level	Coefficient ± Standard error	(t-statistic)	Significance level
Price during past year	Average yield, past 2 years	59.72%	0.72 ± .15	(4.8)	0.05%	-0.23 ± .08	(2.8)	1.6%
	Average yield, past 3 years	70.76%	0.90 ± .15	(6.0)	0.01%	-0.34 ± .08	(4.0)	0.18%
	Average yield, past 4 years	78.96%	0.96 ± .13	(7.3)	0.01%	-0.40 ± .07	(5.5)	0.01%
Average price, past 2 years	Average yield, past 2 years	43.62%	0.63 ± .18	(3.6)	0.39%	-0.24 ± .11	(2.1)	5.4%
	Average yield, past 3 years	49.79%	0.77 ± .19	(4.0)	0.19%	-0.36 ± .13	(2.7)	2.0%
	Average yield, past 4 years	60.92%	0.85 ± .17	(4.9)	0.04%	-0.47 ± .12	(3.8)	0.25%

Notes: Regression equations include coefficients not listed in this table.

Each t-statistic is expressed in terms of its absolute value.

(Continues to next page)

(Table 5.40, continued)

Part C: Regression equations to split the wheat and barley area from the other nonrice area

Price used to calculate expected revenue	Yield used to calculate expected revenue	Adjusted R^2 statistic	ln(Expected revenue from wheat and barley)		
			Coefficient ± Standard error	(t-statistic)	Significance level
Price during past year	Average yield, past 2 years	89.06%	1.0 ± 0.4	(2.7)	2.0%
	Average yield, past 3 years	92.25%	1.5 ± 0.4	(3.9)	0.21%
	Average yield, past 4 years	90.85%	1.4 ± 0.4	(3.3)	0.61%
Average price, past 2 years	Average yield, past 2 years	89.92%	1.1 ± 0.4	(3.0)	1.1%
	Average yield, past 3 years	94.61%	1.8 ± 0.3	(5.2)	0.02%
	Average yield, past 4 years	93.55%	1.9 ± 0.4	(4.5)	0.07%

Part D: Regression equations to split the wheat area from the barley area

Price used to calculate expected revenue	Yield used to calculate expected revenue	Adjusted R^2 statistic	ln(Expected revenue: wheat/barley)		
			Coefficient ± Standard error	(t-statistic)	Significance level
Price during past year	Average yield, past 2 years	45.49%	1.3 ± 0.4	(3.6)	0.35%
	Average yield, past 3 years	62.78%	2.2 ± 0.4	(5.0)	0.03%
	Average yield, past 4 years	51.00%	2.9 ± 0.7	(3.9)	0.17%
Average price, past 2 years	Average yield, past 2 years	46.98%	1.3 ± 0.4	(3.7)	0.29%
	Average yield, past 3 years	64.74%	2.2 ± 0.4	(5.2)	0.02%
	Average yield, past 4 years	55.21%	2.9 ± 0.7	(4.3)	0.09%

Notes: Regression equations include coefficients not listed in this table.
Each t-statistic is expressed in terms of its absolute value.

Source: Model estimates.

Table 5.41--Regressed time trends for seed usage rates

Dependent variable	Regression statistics	Intercept	Time trend YEAR	Comments
ln(Rice seed used / rice production)	-3.87%	-0.3 ± 6.7 (0.04) 97%	-0.0023 ± .0034 (0.69) 50%	Insignificant $\overline{R}^2$ and time coefficient.
ln(Wheat seed used / wheat production)	75.13%	-112 ± 16 (6.8) 0.01%	0.055 ± .008 (6.6) 0.01%	
ln(Barley seed used / barley production)	56.58%	-72 ± 16 (4.6) 0.05%	0.035 ± .008 (4.4) 0.07%	

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variables: JPLQZSRI = Japan, logarithm of ratio: (rice used as seed) / (rice production)
JPLQZSWH = Japan, logarithm of ratio: (wheat used as seed) / (wheat production)
JPLQZSBA = Japan, logarithm of ratio: (barley used as seed) / (barley production)

Independent variable: YEAR = Japanese fiscal year (values from 1965 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

	Coefficient ± Standard error
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

1/ A comparable variable cannot be derived by just calculating the logarithm of the diversion payment, since that payment equaled zero through 1968, and the logarithm of zero is undefined.

2/ For a more thorough discussion of the difference between "static" and "dynamic" estimation, as well as a set of related issues, see William E. Kost, "Model Validation and the Net Trade Model," Agricultural Economic Research, April 1980, pages 1-16. (That article does not make the same distinction between "estimation" and "simulation" as does this report.)

3/ This model's regression equations have the form:

LOG(Behavior) = a + b LOG(Model's expected revenue) + (Other terms)

Suppose the true relationship is:

LOG(Behavior) = a' + b' LOG(Farmers' expected revenue) + (Other terms)

and:

(Farmers' expected revenue) = (1.05 * Model's expected revenue)

Then:

LOG(Behavior) = a' + b' LOG(1.05 * Model's expected revenue) + (Other terms)

LOG(Behavior) = a' + b' LOG(1.05) + b' LOG(Model's expected revenue) + (Other terms)

LOG(Behavior) = a" + b' LOG(Model's expected revenue) + (Other terms)

with a" = a' + b' LOG(1.05). However, this result cannot be distinguished from the model's regression equation, where a = a" and b = b'.

4/ The author experimented with two approaches aside from the nested logit framework. In the multinomial logit approach, the dependent variables in behavioral equations are the logarithm of the ratio of the rice area to the other nonrice area, the logarithm of the ratio of the wheat area to the other nonrice area, and the logarithm of the ratio of the barley area to the other nonrice area; where the other nonrice area is defined as the total area minus the rice, wheat, and barley areas. In the "semi-nested" approach, the dependent variables in behavioral equations are the logarithm of the ratio of the rice area to the nonrice area, the logarithm of the ratio of the wheat area to the other nonrice area, and the logarithm of the ratio of the barley area to the other nonrice area. A set of identities appropriate to each approach transforms estimated logarithms of area ratios into estimated areas.

5/ The change in the rice area planted (measured in hectares) which would follow a 1 percent rise in all grain prices depends on what else is happening. To illustrate, one can hold constant the effect of population growth and examine two cases. If income per capita is held constant while all grain prices go up by 1 percent, then the total area planted to all crops would increase 0.2 percent, and the rice area would rise 0.8 percent

(0.2 percent from the increase in total area plus 0.6 percent from the reallocation of crop shares). But if the 1 percent rise in grain prices is accompanied by a 1 percent growth in income per capita, then the total area planted would fall 0.2 percent, and the rice area would increase only 0.4 percent (with the 0.2 percent loss in total area partly offsetting the 0.6 percent gain from the reallocation of crop shares).

6/ The area planted to fodder crops increased from 520 thousand hectares in 1965 to 939 thousand hectares in 1979, according to the MAF/MAFF Abstract of Statistics, page 20 in the 1968 edition and page 51 in the 1979 edition.

CHAPTER SIX

PUTTING IT ALL TOGETHER: FOOD BALANCE RELATIONSHIPS

SUMMARY

Because rice trade has been the creature of government policy, especially since 1969, it is treated as a policy variable. For now, the quantity of net exports is taken as a "given"; in subsequent chapters, it will be modeled explicitly.

Changes in the stocks of rice are the residual in an identity whose other components are either policy-set (net exports, use as feed), or else determined by behavioral equations derived in previous chapters (food, production net of seed used).

Identity:

[72] JPQARIFY = JPQPRIFY - JPQDRIFY - JPQFRIFY - JPQTRIFY

where:

JPQARIFY = Japan, rice added to stocks, fiscal year (thousand metric tons, brown basis)

JPQPRIFY = Japan, rice production net of seed used, fiscal year (thousand metric tons, brown basis)

JPQDRIFY = Japan, rice used as food, fiscal year (thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year (thousand metric tons, brown basis)

JPQTRIFY = Japan, rice net exports, fiscal year (thousand metric tons, brown basis)

For grains other than rice, changes in stock levels appear to approximate a random walk. This model assumes that changes in stocks on average equal zero.

Behavioral equations:

[73] JPQAWHFY = 0

[74] JPQACNFY = 0

[75] JPQACGFY = 0

where:

JPQAaaFY = Japan, additions to stocks of aa, fiscal year (thousand metric tons); with aa from the list:

WH = wheat
CN = corn
CG = other coarse grains

Estimated net trade then follows from its identity to estimated production net of seed, minus estimated food, minus estimated feed, minus (assumed zero) additions to stocks.

Identities:

[76] JPQTWHFY = JPQPWHFY - JPQDWHFY - JPQFWHFY - JPQAWHFY

[77] JPQTCNFY = JPQPCNFY - JPQDCNFY - JPQFCNFY - JPQACNFY

[78] JPQTCGFY = JPQPCGFY - JPQDCGFY - JPQFCGFY - JPQACGFY

where:

JPQTaaFY = Japan, net exports of aa, fiscal year (thousand metric tons); with aa defined as above

JPQPaaFY = Japan, production of aa net of seed used, fiscal year (thousand metric tons); with aa defined as above

JPQDaaFY = Japan, quantity of aa used as food, fiscal year (thousand metric tons); with aa defined as above

JPQFaaFY = Japan, quantity of aa used as feed, fiscal year (thousand metric tons); with aa defined as above

JPQAaaFY = Japan, quantity of aa added to stocks, fiscal year (thousand metric tons); with aa defined as above

REVIEW OF DATA ON CHANGES IN STOCKS AND ON NET TRADE

Table 6.1 reviews the data which form the subject of this chapter: trade and changes in stocks. Following GOL conventions, trade is measured as net exports. Thus negative numbers represent those grains for which Japan is a net importer.

MODELING APPROACH

To the extent that a country produces more grain than it uses as food, feed, or seed, the surplus must either be exported or added to local stockpiles. 1/ Similarly, when a country produces less than it consumes, the deficit can be obtained only by importing (negative exports), or by depleting local inventories (negative additions to stocks).

Table 6.1--Additions to stocks and net exports of grains

Fiscal year	Additions to stocks				Net trade			
	Rice	Wheat	Corn	Other coarse grains	Rice	Wheat	Corn	Other coarse grains
	Thousand metric tons							
1960	459	179	--	--	-219	-2,613	--	--
1961	-566	180	--	--	-77	-2,589	--	--
1962	-124	-244	--	--	-182	-2,397	--	--
1963	-359	-235	--	--	-239	-3,339	--	--
1964	-275	142	--	--	-502	-3,403	--	--
1965	468	100	--	--	-1,052	-3,444	--	--
1966	921	65	--	--	-679	-4,024	--	--
1967	2,334	42	--	--	-364	-4,151	--	--
1968	2,428	-198	--	--	-230	-3,882	--	--
1969	1,646	-31	--	--	392	-4,456	--	--
1970	-281	-159	--	--	770	-4,574	--	--
1971	-3,295	-95	--	--	849	-4,671	--	--
1972	-1,670	173	-84	-161	458	-5,212	-6,364	-5,389
1973	-801	35	666	167	392	-5,331	-8,021	-6,176
1974	51	174	-30	135	208	-5,459	-7,719	-6,655
1975	1,228	344	-47	-12	-27	-5,681	-7,568	6,110
1976	-32	63	45	264	-15	-5,501	-8,612	7,245
1977	1,583	133	-114	78	29	-5,658	-9,313	-7,663
1978	1,269	183	260	-62	-44	-5,677	-10,736	-7,440
1979	-108	61	371	74	848	-5,540	-11,707	-8,032

Note: The rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Taken from Tables 2.1 through 2.5, which in turn are based on Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 516-517 in the 1979/80 edition and the equivalent table in earlier editions, and its revised Food Balance Sheets: 1955-1966. A correction to the figure published in the 1977 Food Balance Sheet for additions to corn stocks (-114 instead of +597) was furnished by William L. Davis, Agricultural Counselor, American Embassy, Tokyo, on the basis of conversations with MAFF officials (personal correspondence to William T. Coyle and the author, February 17, 1983).

Japan's rice production rose to a level sufficient to cover its food and feed requirements in 1966. Through 1968, the country still imported significant quantities of rice in order to build up stocks. Since 1969, Japan's rice imports have been very small--well under 100 thousand metric tons annually. Japan is able to export significant quantities of rice only when the government provides generous subsidies to cover the difference between the high domestic price and the world price. (As usual in such cases, the subsidized exports are called "food aid" by the government but are called "dumping" by export competitors.) Because Japanese rice trade has been so dominated by government actions, especially since 1969, this model treats it as a policy variable. Government policies including subsidized rice exports will be modeled in the next two chapters; until then, the level of trade is taken as a "given". This leaves changes in rice stocks as the residual in the food balance equation. Stock accumulation is not just the leftover quantity in this mathematical identity--it is also the leftover in a real sense. Large inventories are the undesired outcome of government policies which maintain the Japanese price of rice far above the level prevailing in international trade.

Inventories of wheat, corn, and other coarse grains are increased or decreased voluntarily by private firms and government agencies, in response to market conditions and policy considerations like food security. But this model, designed to analyze and project long-range trends, is not able to accurately portray year-to-year fluctuations in stocks. Consequently, inventory levels of nonrice grains are assumed to follow a random walk, with positive and negative changes in stocks averaging to zero. Net exports are then estimated as being equal to production less seed, food, and feed consumption.

The first of two appendices to this chapter describes efforts to model changes in the stocks of wheat, corn, and other coarse grains. For coarse grains (but not wheat), simple behavioral equations track changes in stocks reasonably well. But the model cannot accurately predict the explanatory variables used in those equations, so the venture collapses. The second appendix presents regressions which directly estimate net imports of wheat, corn, and other coarse grains as time trends. These net import equations provide benchmarks with which to judge the model's success in calculating net trade as the difference between estimated Japanese supply and estimated Japanese demand.

RICE

The amount of rice added to stocks is determined by the following equation:

$$JPQARIFY = JPQPRIFY - JPQDRIFY - JPQFRIFY - JPQTRIFY$$

where:

JPQARIFY = Japan, rice added to stocks, fiscal year
(thousand metric tons, brown basis)

JPQPRIFY = Japan, rice production net of seed used, fiscal year
(thousand metric tons, brown basis)

JPQDRIFY = Japan, rice used as food, fiscal year
(thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year
(thousand metric tons, brown basis)

JPQTRIFY = Japan, rice net exports, fiscal year
(thousand metric tons, brown basis) 2/

Table 6.2 and Figure 6.1 compare actual and calculated values for changes in rice stocks. It is easier to assess the quality of the estimates from the graph than from the table. The percentage errors reported in the table are not too meaningful, since they tend to explode when the true change in stocks is near zero. The error terms measured in thousand metric tons are unquestionably pertinent. And thus measured, the error terms are disconcertingly large, with an average absolute value of 664 thousand metric tons.

However, surplus rice production affects government policies only to the extent that it is perceived as a long-term trend. As shown in the following chapter, a measure of the rice surplus more relevant to government decisions is the excess of rice production over seed and food demand, averaged over the previous 6 years. This variable also equals the sum of rice added to stocks, rice sold as feed, and net rice exports (a logical combination, since heavily subsidizing feed use or exports are alternatives to stockpiling surplus rice). Actual and dynamically estimated values of the policy-relevant excess rice production variable are displayed in Table 6.3 and Figure 6.2. The process of taking 6-year moving averages greatly reduces both the root mean square and the mean absolute value of the residuals, compared to the results for annual stock changes reported in Table 6.2.

NONRICE GRAINS

Estimated values for net exports of wheat, corn, and other coarse grains are calculated from the identities below:

JPQTWHFY = JPQPWHFY - JPQDWHFY - JPQFWHFY - JPQAWHFY

JPQTCNFY = JPQPCNFY - JPQDCNFY - JPQFCNFY - JPQACNFY

JPQTCGFY = JPQPCGFY - JPQDCGFY - JPQFCGFY - JPQACGFY

where:

JPQTaaFY = Japan, net exports of aa, fiscal year
(thousand metric tons); with aa from the list:

WH = wheat
CN = corn
CG = other coarse grains

JPQPaaFY = Japan, production of aa net of seed used, fiscal year
(thousand metric tons); with aa defined as above

JPQDaaFY = Japan, quantity of aa used as food, fiscal year
(thousand metric tons); with aa defined as above

JPQFaaFY = Japan, quantity of aa used as feed, fiscal year (thousand metric tons); with aa defined as above

JPQAaaFY = Japan, quantity of aa added to stocks, fiscal year (thousand metric tons); with aa defined as above

In these calculations for estimated net exports, the quantity added to stocks is assumed to be zero. Estimated quantities of food and feed are taken from Chapters Three and Four; while dynamically estimated quantities of production net of seed are taken from Chapter Five.

For purposes of presentation, net exports are multiplied by -1, converting them into net imports. Actual and estimated values for net imports of wheat, corn, and other coarse grains are shown in Tables 6.4 to 6.6 and in Figures 6.3 to 6.5. Despite the practice of ignoring changes in stocks--which become part of the error term--the model reproduces past trade patterns with reasonable fidelity.

REGRESSIONS FOR ADDITIONS TO STOCKS

It is easy to see that the errors associated with the estimated net imports of wheat, corn, and other coarse grains approximately parallel changes in stocks (Figures 6.6 to 6.8). Thus an accurate account of changes in inventories would substantially reduce errors in the estimation of net trade. The purpose of this section is to clarify what can be done to model additions to stocks--and what cannot be done.

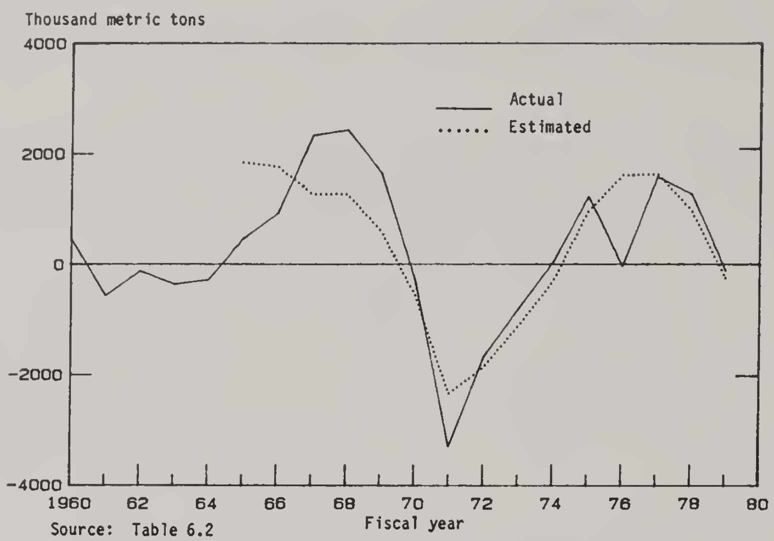
There are two main reasons for holding stocks.

The transactions demand is to hold inventories to allow steady consumption despite an irregular supply. The variation in supply may be predictable, as is the case with gaps between harvests of domestic supplies and gaps between shipments of imported supplies; or the supply variation may be unpredictable, as is the case with abnormal harvests due to unusual weather. As a first approximation, the size of the desired inventory will vary in proportion to the volume of food and feed consumption. Thus year-to-year changes in stocks will vary in proportion to year-to-year changes in the volume of demand. Year-to-year fluctuations in supply (such as bumper crops or crop failures) are also important determinants of changes in stocks. However, there is virtually nothing to be gained from an attempt to make a long-range model of the effects of short-range supply fluctuations, because the supply fluctuations are themselves unpredictable.

A second motivation for changes in stocks is speculative demand. Here stocks are built up or drawn down to smooth variations in prices, instead of smoothing variations in the quantities consumed. When prices are unusually high, it makes sense to sell from inventories rather than purchase on the spot market; and in the following year, when prices are likely to return towards normal levels, to rebuild inventories towards their normal levels. On the other hand, when prices are unusually low, it makes sense to put away grains in storage; and in the following year, when prices are likely to be higher, to sell this cheaply acquired grain out of stocks. A government agency trying to stabilize prices and a private grain company trying to maximize its profits

--Text continues to page 194.

Figure 6.1
Actual and Estimated Additions to Stocks of Rice in Japan



Source: Table 6.2

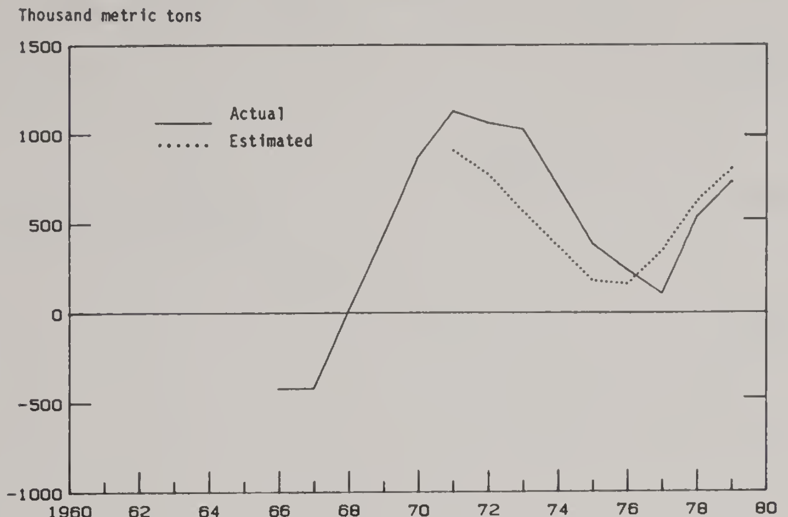
Table 6.2--Actual and estimated additions to stocks of rice

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	---- Thousand metric tons ----			Percent
1960	459	--	--	--
1961	-566	--	--	--
1962	-124	--	--	--
1963	-359	--	--	--
1964	-275	--	--	--
1965	468	1,842	-1,374	-294
1966	921	1,769	-848	-92
1967	2,334	1,271	1,063	46
1968	2,428	1,275	1,153	47
1969	1,646	610	1,036	63
1970	-281	-548	267	-95
1971	-3,295	-2,335	-960	29
1972	-1,670	-1,859	189	-11
1973	-801	-1,117	316	-39
1974	51	-310	361	708
1975	1,228	952	276	22
1976	-32	1,616	-1,648	5,150
1977	1,583	1,638	-55	-3
1978	1,269	983	286	23
1979	-108	-238	130	-120
		Mean absolute value:	664	450
		Root mean square:	828	1,345

Note: Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Calculated from Table 6.1 and model estimates.

Figure 6.2
Actual and Estimated Average of Excess Rice Production During Previous Six Years



Source: Table 6.3

Table 6.3--Actual and estimated average of excess rice production during previous six years

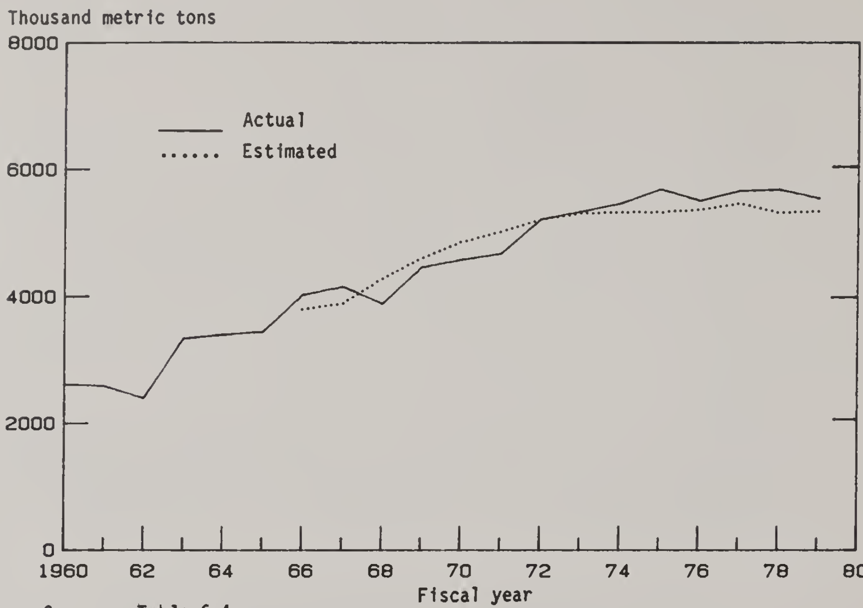
Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1966	-423	--	--	--
1967	-421	--	--	--
1968	16	--	--	--
1969	434	--	--	--
1970	872	--	--	--
1971	1,126	909	217	19
1972	1,060	775	285	27
1973	1,024	566	458	45
1974	706	372	334	47
1975	381	179	202	53
1976	238	164	74	31
1977	105	350	-245	-233
1978	535	628	-93	-17
1979	732	809	-77	-11
		Mean absolute value:	221	54
		Root mean square:	252	84

Notes: Excess rice production is defined as domestic supply minus seed and food demand. It equals additions to stocks plus net exports plus feed use.

Rice statistics in this table are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Actual values are calculated from data in Table 2.1. Estimated values are calculated as estimated additions to stocks (from Table 6.2), plus actual net exports and feed use (both from Table 2.1).

Figure 6.3
Actual and Estimated Net Imports of Wheat in Japan



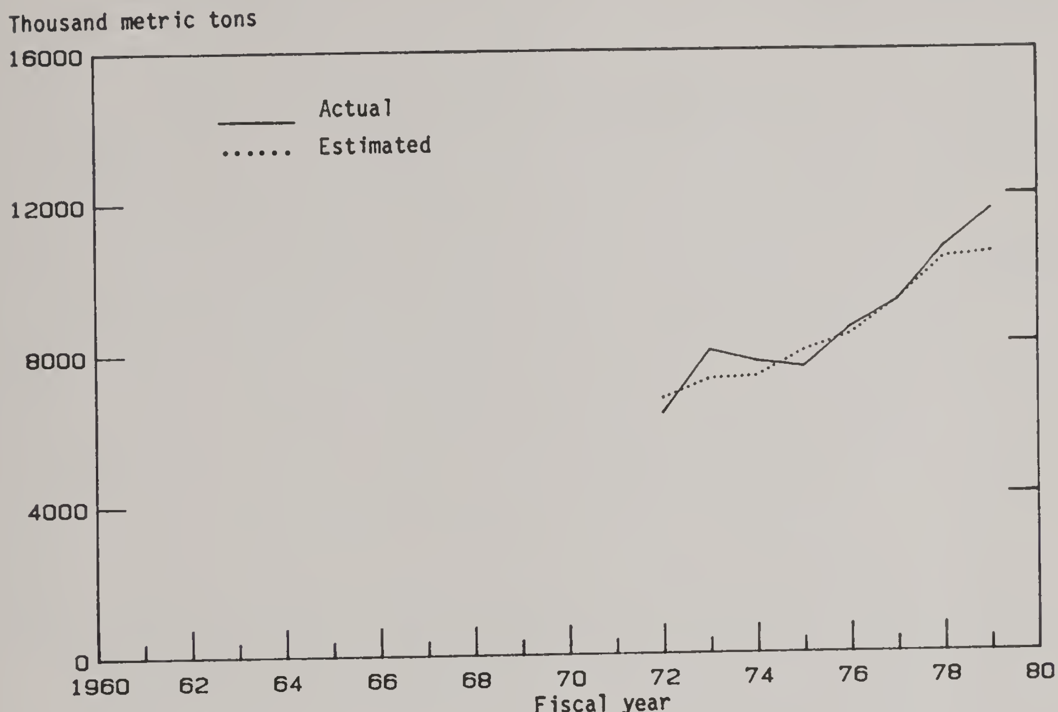
Source: Table 6.4

Table 6.4--Actual and estimated net imports of wheat

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1960	2,613	--	--	--
1961	2,589	--	--	--
1962	2,397	--	--	--
1963	3,339	--	--	--
1964	3,403	--	--	--
1965	3,444	--	--	--
1966	4,024	3,800	224	5.6
1967	4,151	3,891	260	6.3
1968	3,882	4,280	-398	-10.3
1969	4,456	4,601	-145	-3.3
1970	4,574	4,850	-276	-6.0
1971	4,671	5,018	-347	-7.4
1972	5,212	5,211	1	0.0
1973	5,331	5,300	31	0.6
1974	5,459	5,324	135	2.5
1975	5,681	5,323	358	6.3
1976	5,501	5,365	136	2.5
1977	5,658	5,458	200	3.5
1978	5,677	5,319	358	6.3
1979	5,540	5,336	204	3.7
		Mean absolute value:	220	4.6
		Root mean square:	249	5.3

Sources: Calculated from Table 6.1 and model estimates.

Figure 6.4
Actual and Estimated Net Imports of Corn in Japan



Source: Table 6.5

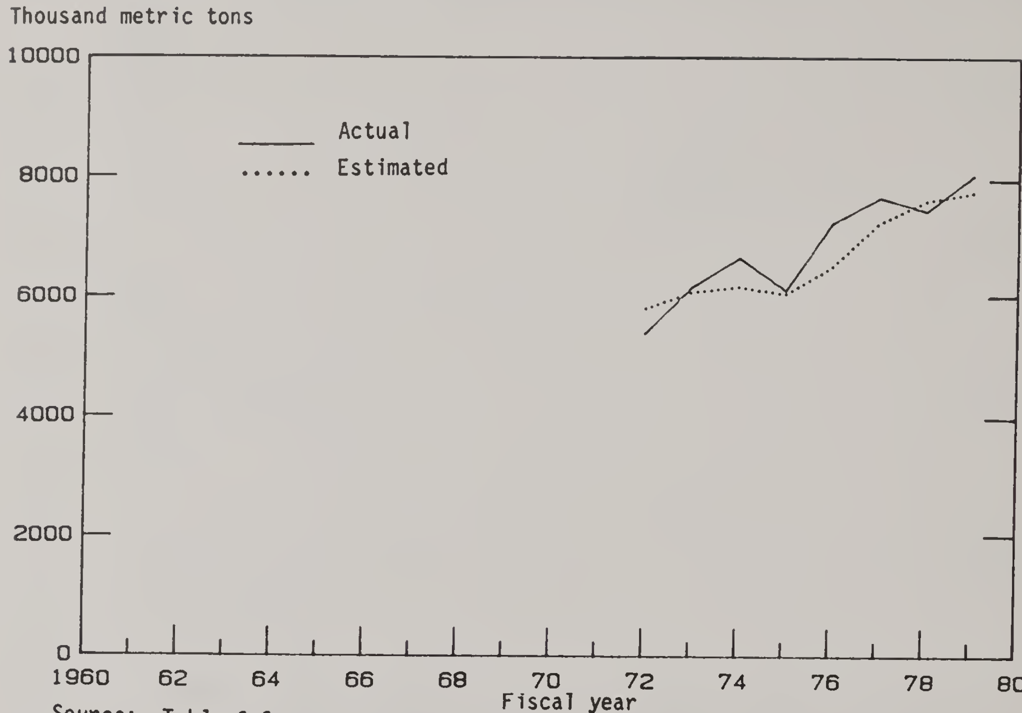
Table 6.5--Actual and estimated net imports of corn

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	---- Thousand metric tons		----	Percent
1972	6,364	6,759	-395	-6.2
1973	8,021	7,270	751	9.4
1974	7,719	7,331	388	5.0
1975	7,568	7,996	-428	-5.7
1976	8,612	8,431	181	2.1
1977	9,313	9,328	-15	-0.2
1978	10,736	10,452	284	2.6
1979	11,707	10,585	1,122	9.6
		Mean absolute value:	446	5.1
		Root mean square:	551	6.0

Sources: Calculated from Table 6.1 and model estimates.

Figure 6.5

Actual and Estimated Net Imports of Other Coarse Grains in Japan



Source: Table 6.6

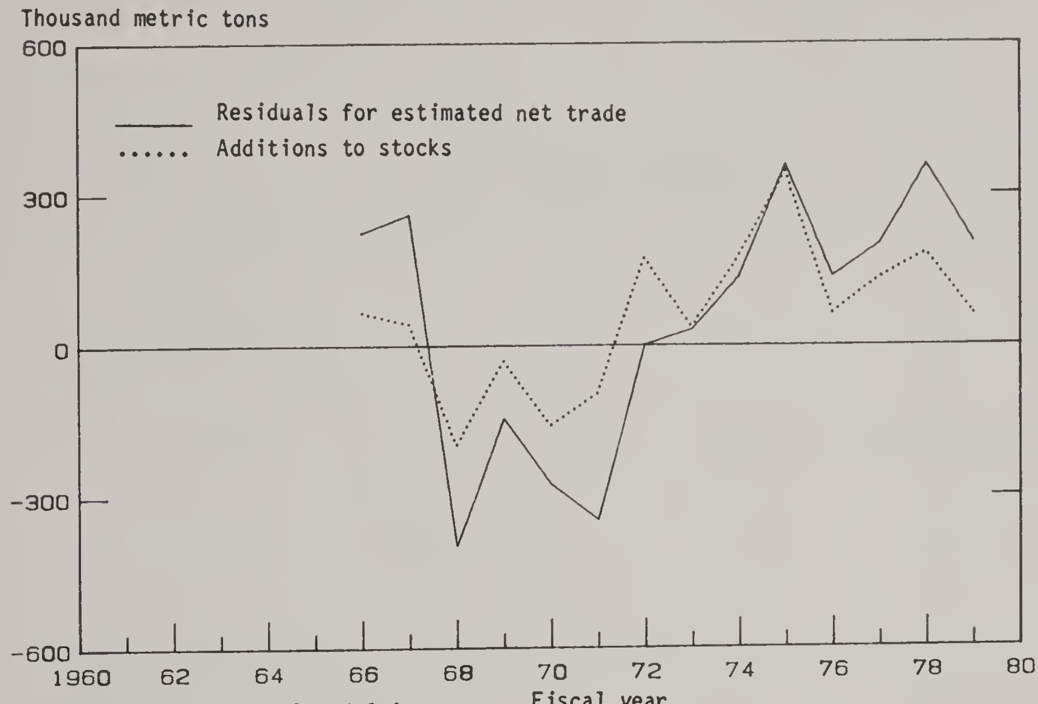
Table 6.6--Actual and estimated net imports of other coarse grains

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent
1972	5,389	5,804	-415	-7.7
1973	6,176	6,086	90	1.5
1974	6,655	6,173	482	7.2
1975	6,110	6,050	60	1.0
1976	7,245	6,514	731	10.1
1977	7,663	7,249	414	5.4
1978	7,440	7,609	-169	-2.3
1979	8,032	7,752	280	3.5
		Mean absolute value:	330	4.8
		Root mean square:	392	5.7

Sources: Calculated from Table 6.1 and model estimates.

Figure 6.6

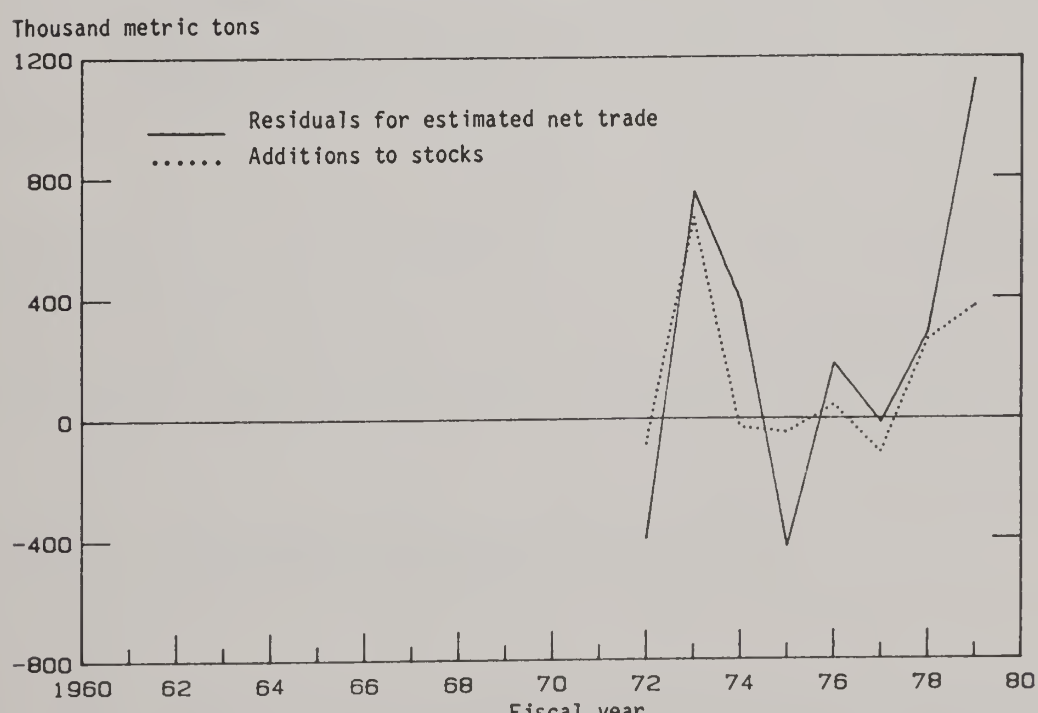
Residuals from Net Trade Estimates and Additions to Stocks of Wheat in Japan



Sources: Tables 6.1 and 6.4

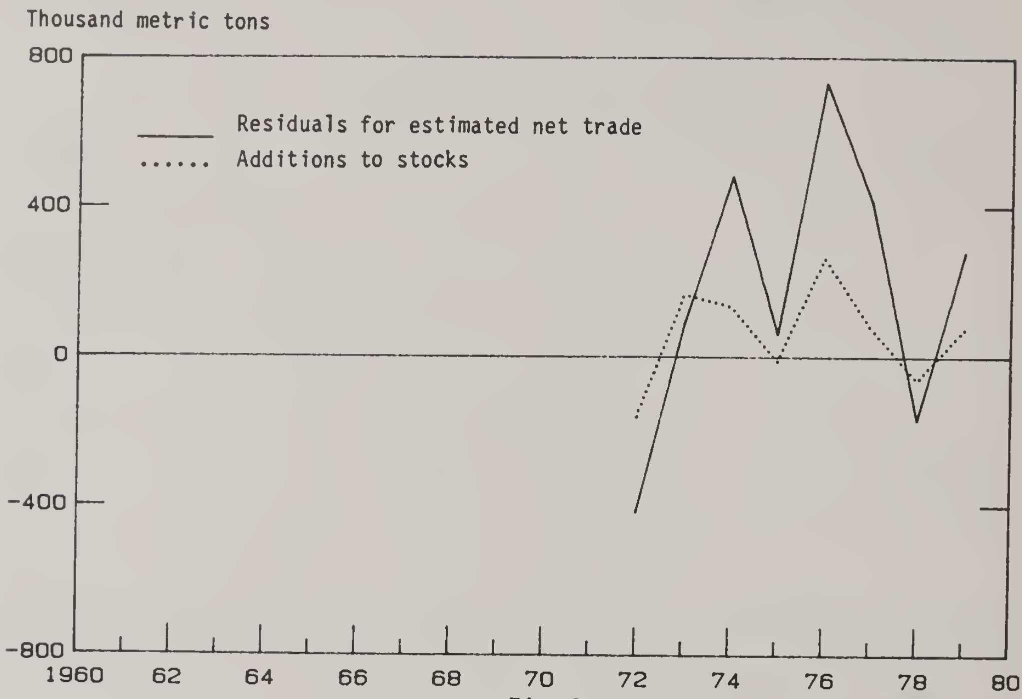
Figure 6.7

Residuals from Net Trade Estimates and Additions to Stocks of Corn in Japan



Sources: Tables 6.1 and 6.5

Figure 6.8
Residuals from Net Trade Estimates and
Additions to Stocks of Other Coarse Grains in Japan



Sources: Tables 6.1 and 6.6

---

will both be motivated to act in this manner (though a government agency generally will seek a different degree of price stability than a profit maximizing firm). In summary, a rise in price during a given year should be accompanied by a reduction of stocks in that year, compensated by an addition to stocks in the following year. By the same reasoning, a fall in price during a given year should be accompanied by an addition to stocks in that year, compensated by a reduction of stocks in the following year.

In this study, the variable used to measure the effect of transactions demand on stock changes is the difference between the current and previous years' food plus feed consumption. Two pairs of variables are used to measure the effect of speculative demand: the current and lagged change in trade price, or else the current and lagged change in the trade price relative to the previous year's trade price. This last pair of variables can be expressed as:

$$\text{(Trade price ratio)} = \frac{\text{(Trade price this year)} - \text{(Trade price last year)}}{\text{(Trade price last year)}}$$

$$\text{(Lagged trade price ratio)} = \text{(Trade price ratio for previous year)}$$

with all prices measured in terms of 1970 yen per kilogram.

Tables 6.7, 6.8, and 6.9 display regression equations for additions to stocks.

The adjusted R^2 statistics listed in Table 6.7 show that the best regression equation for wheat does not explain even 15 percent of the variance in additions to stocks. This dismal record is not worth pursuing further.

The regressions for corn and for other coarse grains (Tables 6.8 and 6.9) bring into evidence a practical difficulty: the Japanese food balance sheet data used to calibrate this model span only eight years. When changes in food plus feed consumption enter the regression equation, the number of observations is reduced to seven--too few to reliably estimate both a transactions demand coefficient and speculative demand coefficients.

For corn, the speculative factor emerges as predominant. Thus the best regression equation is:

$$
\begin{array}{llllll}
\text{JPQACNFY} = & 120.790 & + & 931.258\ \text{JPRDPTCN} & - & 698.700\ \text{LAG1(JPRDPTCN)} \\
 & \pm\ 36.433 & & \pm\ 152.733 & & \pm\ 160.854 \\
 & (3.315) & & (6.097) & & (4.344) \\
 & 2.11\% & & 0.17\% & & 0.74\%
\end{array}
$$

Adjusted R^2 = 87.36 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 3.230
Autocorrelation of residuals = -0.559

JPQACNFY = Japan, corn added to stocks, fiscal year (thousand metric tons)

JPRDPTCN = Japan, ratio: (change in corn trade price since previous calendar year, measured in 1970 yen per kilogram) / (corn trade price during previous calendar year, measured in 1970 yen per kilogram)

LAG1(x) = value of "x" lagged by 1 year

The estimates derived from this equation are compared to actual values in Table 6.10 and Figure 6.9. The quality of the regression equation is more easily judged from the graph.

Although the coefficients for the current and lagged changes in trade price are strongly significant, they have the wrong sign. What seems to have happened is that the extraordinary rise in real prices for grains in 1973 (and to a lesser extent, the rise in 1979 real prices) caused the Japanese to believe that real grain prices would continue to climb in following years. As a result, they <u>increased</u> their corn stocks in times of rising prices. Therefore using this regression equation to predict future changes in stocks implies an assumption that the Japanese will continue to overreact to changes in corn trade prices.

For other coarse grains, the transactions demand for stocks appears to predominate over the speculative demand (see Table 6.9). There is weak evidence that the speculative demand for other coarse grain inventories

--Text continues to page 203.

Table 6.7--Regression equations for additions to stocks of wheat

Regression statistics	Intercept	Change in consumption JPDDFWHF	Change in trade price JPDPTWH	Lagged change in trade price JPDPTWH1	Trade price ratio JPRDPTWH	Lagged trade price ratio JPRDPTW1	Comments
-0.44% 1.246 .375	21 $\pm$ 54 (0.38) 71%	0.38 $\pm$ .39 (0.97) 35%					Insignificant $\bar{R}^2$, poor coefficient for change in consumption.
-4.08% 1.114 .441	53 $\pm$ 38 (1.4) 19%		-5.2 $\pm$ 7.7 (0.67) 51%				Insignificant $\bar{R}^2$ and coefficient for change in price.
-2.59% 1.124 .436	63 $\pm$ 39 (1.6) 13%		-6.8 $\pm$ 7.8 (0.87) 40%	8.7 $\pm$ 8.0 (1.1) 30%			Insignificant $\bar{R}^2$, poor coefficients for changes in price.
-1.43% 0.990 .505	3 $\pm$ 58 (0.05) 96%	0.47 $\pm$ .41 (1.2) 27%	-7.3 $\pm$ 7.8 (0.94) 37%				Insignificant $\bar{R}^2$, poor coeff. for changes in consumption and price.
14.33% 0.810 .587	-9 $\pm$ 53 (0.17) 87%	0.74 $\pm$ .40 (1.8) 9.4%	-11 $\pm$ 8 (1.5) 17%	14 $\pm$ 8 (1.8) 10%			Poor $\bar{R}^2$, weak coefficients for changes in price.
-5.73% 1.143 .426	57 $\pm$ 38 (1.5) 15%				-83 $\pm$ 169 (0.49) 63%		Insignificant $\bar{R}^2$ and coefficient for change in price.
-6.18% 1.201 .396	64 $\pm$ 38 (1.7) 12%				-113 $\pm$ 172 (0.66) 53%	178 $\pm$ 183 (0.97) 35%	Insignificant $\bar{R}^2$ and coefficient for current change in price, poor coeff. for lagged change in price.
-3.70% 1.019 .490	9 $\pm$ 57 (0.15) 88%	0.46 $\pm$ .41 (1.1) 28%			-133 $\pm$ 173 (0.77) 46%		Insignificant $\bar{R}^2$, poor coeff. for changes in consumption and price.
6.37% 1.003 .495	-2 $\pm$ 55 (0.05) 97%	0.67 $\pm$ .42 (1.6) 13%			-202 $\pm$ 171 (1.2) 26%	276 $\pm$ 182 (1.5) 16%	Poor $\bar{R}^2$ and coefficient for current change in price, weak coefficients for change in consumption and lagged change in price.

(Continues to next page)

(Table 6.7, continued)

All regressions were run over the 15-year interval spanning Japanese fiscal years 1965-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPQAWHFY = Japan, wheat added to stocks, fiscal year (thousand metric tons)

Independent variables:
- JPDDFWHF = Japan, change in wheat food plus feed consumption since previous fiscal year (thousand metric tons)
- JPDPTWH = Japan, change in wheat trade price since previous calendar year (1970 yen per kilogram)
- JPDPTWH1 = value of JPDPTWH in previous year
- JPRDPTWH = Japan, ratio: (change in wheat trade price since previous calendar year, measured in 1970 yen per kilogram) / (wheat trade price during previous calendar year, measured in 1970 yen per kilogram)
- JPRDPTW1 = value of JPRDPTWH in previous year

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 6.8--Regression equations for additions to stocks of corn

Regression statistics	Intercept	Change in consumption JPDDFCNF	Change in trade price JPDPTCN	Lagged change in trade price JPDPTCN1	Trade price ratio JPRDPTCN	Lagged trade price ratio JPRDPTC1	Comments
5.57% 2.808 .054	-51 ± 212 (0.24) 82%	0.31 ± .27 (1.2) 30%					Poor $\overline{R}^2$ and coefficient for change in consumption.
45.37% 2.559 -.295	179 ± 74 (2.4) 5.2%		48 ± 18 (2.6) 4.0%				Wrong sign for change in price, weak $\overline{R}^2$.
75.88% 3.245 -.608	133 ± 52 (2.6) 5.0%		53 ± 12 (4.3) 0.79%	-37 ± 13 (2.9) 3.3%			Wrong signs for changes in price.
43.46% 3.550 -.698	18 ± 167 (0.11) 92%	0.24 ± .21 (1.2) 31%	42 ± 20 (2.1) 11%				Wrong sign for change in price, poor coefficient for change in consumption, weak $\overline{R}^2$.
89.93% 1.517 .193	467 ± 124 (3.8) 3.3%	-0.54 ± .20 (2.7) 7.2%	65 ± 10 (6.5) 0.74%	-84 ± 19 (4.4) 2.2%			Wrong signs for change in consumption and changes in price.
49.70% 2.329 -.164	164 ± 70 (2.3) 5.8%				851 ± 302 (2.8) 3.1%		Wrong sign for change in price, weak $\overline{R}^2$.
87.36% 3.230 -.559	121 ± 36 (3.3) 2.1%				931 ± 153 (6.1) 0.17%	-699 ± 161 (4.3) 0.74%	EQUATION DISCUSSED IN TEXT. Wrong signs for changes in price.
54.99% 3.424 -.653	-16 ± 147 (0.11) 92%	0.27 ± .18 (1.5) 21%			778 ± 305 (2.5) 6.4%		Wrong sign for change in price, weak coefficient for change in consumption.
88.79% 2.713 -.407	254 ± 105 (2.4) 9.4%	-0.20 ± .16 (1.3) 30%			952 ± 160 (6.0) 0.95%	-974 ± 270 (3.6) 3.6%	Wrong signs for change in consumption and for changes in price.

(Continues to next page)

(Table 6.8, continued)

Regressions including the variable JPDDFCNF were run over the 7-year interval spanning Japanese fiscal years 1973-79. All other regressions were run over the 8-year interval spanning Japanese fiscal years 1972-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPQACNFY = Japan, corn added to stocks, fiscal year (thousand metric tons)

Independent variables: JPDDFCNF = Japan, change in corn food plus feed consumption since previous fiscal year (thousand metric tons)

JPDPTCN = Japan, change in corn trade price since previous calendar year (1970 yen per kilogram)

JPDPTCN1 = value of JPDPTCN in previous year

JPRDPTCN = Japan, ratio: (change in corn trade price since previous calendar year, measured in 1970 yen per kilogram) / (corn trade price during previous calendar year, measured in 1970 yen per kilogram)

JPRDPTC1 = value of JPRDPTCN in previous year

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 6.9--Regression equations for additions to stocks of other coarse grains

Regression statistics	Intercept	Change in consumption JPDDFCGF	Change in trade price JPDPTSG	Lagged change in trade price JPDPTSG1	Trade price ratio JPRDPTSG	Lagged trade price ratio JPRDPTS1	Comments
50.70% 1.205 .462	22 $\pm$ 39 (0.57) 59%	0.20 $\pm$ .07 (2.7) 4.4%					EQUATION DISCUSSED IN TEXT.
-1.67% 2.586 -.047	73 $\pm$ 50 (1.5) 20%		14 $\pm$ 15 (0.94) 38%				Wrong sign for change in price, insignificant $\bar{R}^2$.
-20.30% 2.403 .028	68 $\pm$ 57 (1.2) 28%		15 $\pm$ 16 (0.90) 41%	-5 $\pm$ 17 (0.27) 80%			Wrong signs for changes in price, insignificant $\bar{R}^2$.
44.50% 1.116 .394	28 $\pm$ 42 (0.66) 55%	0.19 $\pm$ .08 (2.5) 7.1%	6.1 $\pm$ 9.2 (0.67) 54%				Wrong sign for change in price, weak $\bar{R}^2$.
31.82% 1.773 .115	29 $\pm$ 47 (0.63) 58%	0.21 $\pm$ .09 (2.3) 11%	5 $\pm$ 10 (0.45) 68%	5 $\pm$ 11 (0.51) 65%			Wrong sign for current change in price, insignif. coeff. for lagged change in price, weak $\bar{R}^2$ and coefficient for change in consumption.
0.66% 2.544 -.025	70 $\pm$ 49 (1.4) 20%				242 $\pm$ 236 (1.0) 35%		Wrong sign for change in price, poor $\bar{R}^2$.
-19.13% 2.509 -.012	69 $\pm$ 55 (1.2) 27%				244 $\pm$ 262 (0.93) 39%	-16 $\pm$ 279 (0.06) 96%	Wrong signs for changes in price, insignificant $\bar{R}^2$.
47.76% 1.025 .401	27 $\pm$ 41 (0.67) 54%	0.19 $\pm$ .08 (2.5) 6.6%			122 $\pm$ 143 (0.85) 44%		Wrong sign for change in price, weak $\bar{R}^2$.
37.95% 1.794 .078	30 $\pm$ 45 (0.68) 54%	0.20 $\pm$ .09 (2.4) 9.8%			103 $\pm$ 159 (0.65) 57%	101 $\pm$ 167 (0.61) 59%	Wrong sign for current change in price, insignif. coeff. for lagged change in price, weak $\bar{R}^2$.

(Continues to next page)

(Table 6.9, continued)

Regressions including the variable JPDDFCGF were run over the 7-year interval spanning Japanese fiscal years 1973-79. All other regressions were run over the 8-year interval spanning Japanese fiscal years 1972-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPQACGFY = Japan, other coarse grains added to stocks, fiscal year (thousand metric tons)

Independent variables:
- JPDDFCGF = Japan, change in food plus feed consumption of other coarse grains since previous fiscal year (thousand metric tons)
- JPDPTSG = Japan, change in sorghum trade price since previous calendar year (1970 yen per kilogram)
- JPDPTSG1 = value of JPDPTSG in previous year
- JPRDPTSG = Japan, ratio: (change in sorghum trade price since previous calendar year, measured in 1970 yen per kilogram) / (sorghum trade price during previous calendar year, measured in 1970 yen per kilogram)
- JPRDPTS1 = value of JPRDPTSG in previous year

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

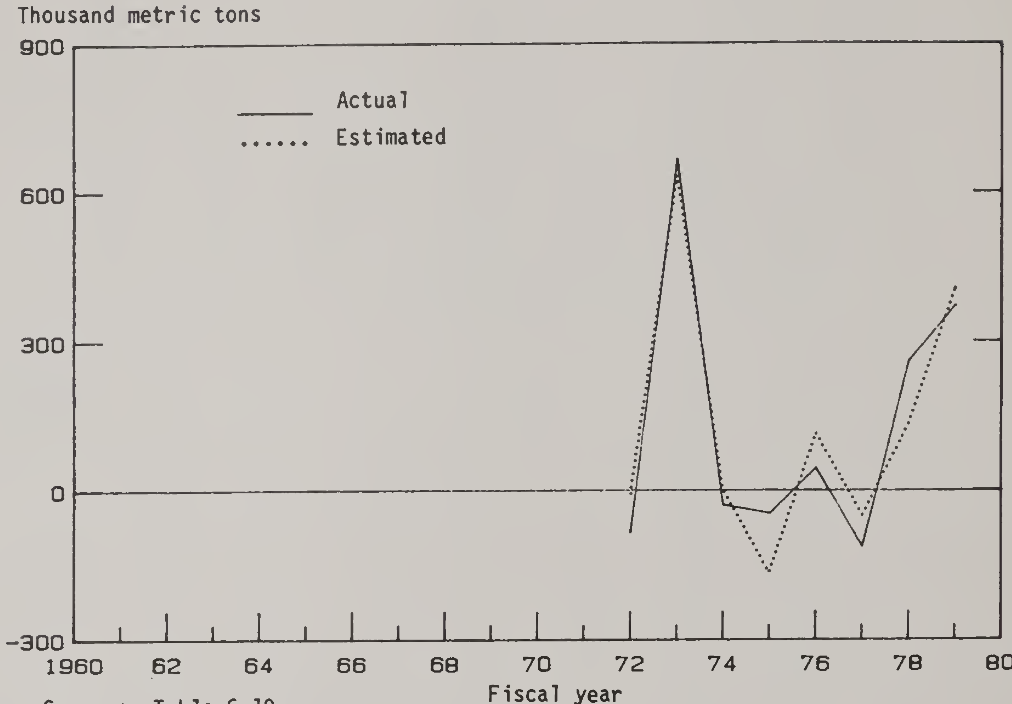
The other numerical cells contain:

Coefficient $\pm$ Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Figure 6.9

Actual and Estimated Additions to Stocks of Corn in Japan



Source: Table 6.10

Table 6.10--Actual and estimated additions to stocks of corn

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1972	-84	-7	-77	92
1973	666	632	34	5
1974	-30	1	-31	103
1975	-47	-166	119	-253
1976	45	116	-71	-158
1977	-114	-50	-64	56
1978	260	135	125	48
1979	371	406	-35	-9
		Mean absolute value:	70	91
		Root mean square:	78	119

Sources: Calculated from Table 6.1 and model estimates.

involves overreactions to changes in trade prices similar to those found for corn. The best regression equation for other coarse grains is:

$$\begin{array}{lcll} \text{JPQACGFY} & = & 22.406537 & + \ 0.199735 \text{ JPDDFCGF} \\ & & \pm 39.013013 & \pm \ 0.074595 \\ & & (0.574) & (2.678) \\ & & 59.06\% & 4.39\% \end{array}$$

Adjusted R^2 = 50.70 percent for 7 observations (JFY 1973-79)
Durbin-Watson statistic = 1.205
Autocorrelation of residuals = 0.462

JPQACGFY = Japan, other coarse grains added to stocks, fiscal year (thousand metric tons)

JPDDFCGF = Japan, change in other coarse grain food plus feed consumption since previous fiscal year (thousand metric tons)

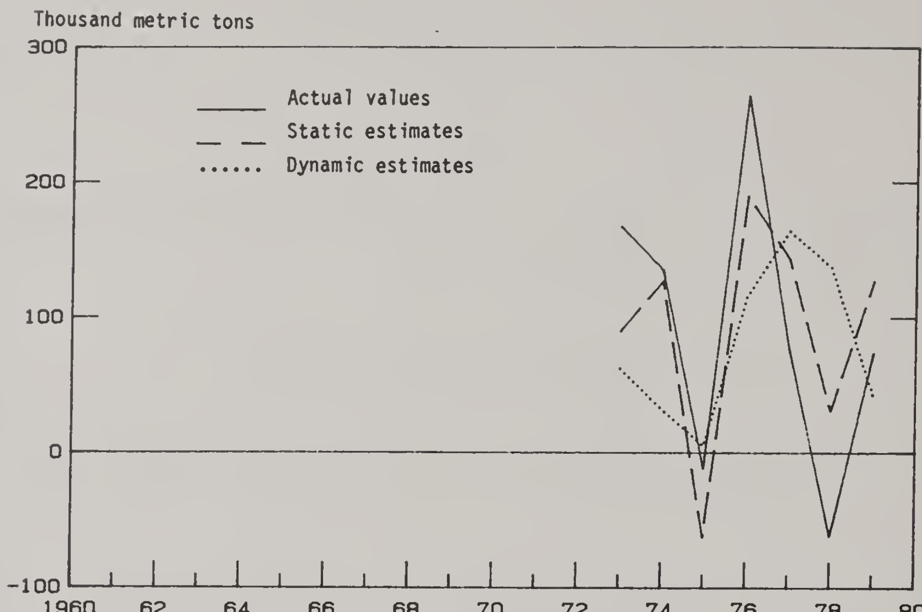
Two series of estimates derived from this regression equation, as well as the actual values for additions to stocks, are displayed in Table 6.11 and Figure 6.10. Again, the graph provides much clearer evidence on the quality of the regression equation than does the table. The static estimates, based on the true values of changes in food plus feed consumption, track the historical record reasonably well. But the dynamic estimates, based on estimated values of changes in food plus feed consumption, track the historical record very poorly. The problem is that although the model provides good estimates of total food plus feed consumption, it does a poor job of estimating year-to-year changes in food plus feed consumption (see Table 6.12 and Figure 6.11). This should not be surprising: for example, if each year's food plus feed demand is estimated with an average error of 5 percent, then there can easily arise a 100 percent error in the estimation of a 5-percent change in food plus feed demand from one year to the next. In conclusion, the Japanese Grains Model, taken as a whole, cannot reliably estimate changes in the stocks of other coarse grains.

If year-to-year changes in consumption cannot be reliably estimated, there is also no hope of reliably estimating year-to-year changes in trade prices. For trade prices are much more volatile than Japanese grain consumption, depending on unpredictable factors like the weather in the world's major growing regions. Thus the apparently accurate equation for additions to corn stocks is also unusable in practice.

REGRESSIONS FOR NET TRADE

Can a much simpler set of equations provide estimates of net trade which are just as good as those generated by the elaborate structure of the Japanese Grains Model? As a benchmark, the following time trends were estimated for net imports per capita of wheat, corn, and other coarse grains.

Figure 6.10
Actual and Estimated Additions to Stocks
of Other Coarse Grains in Japan



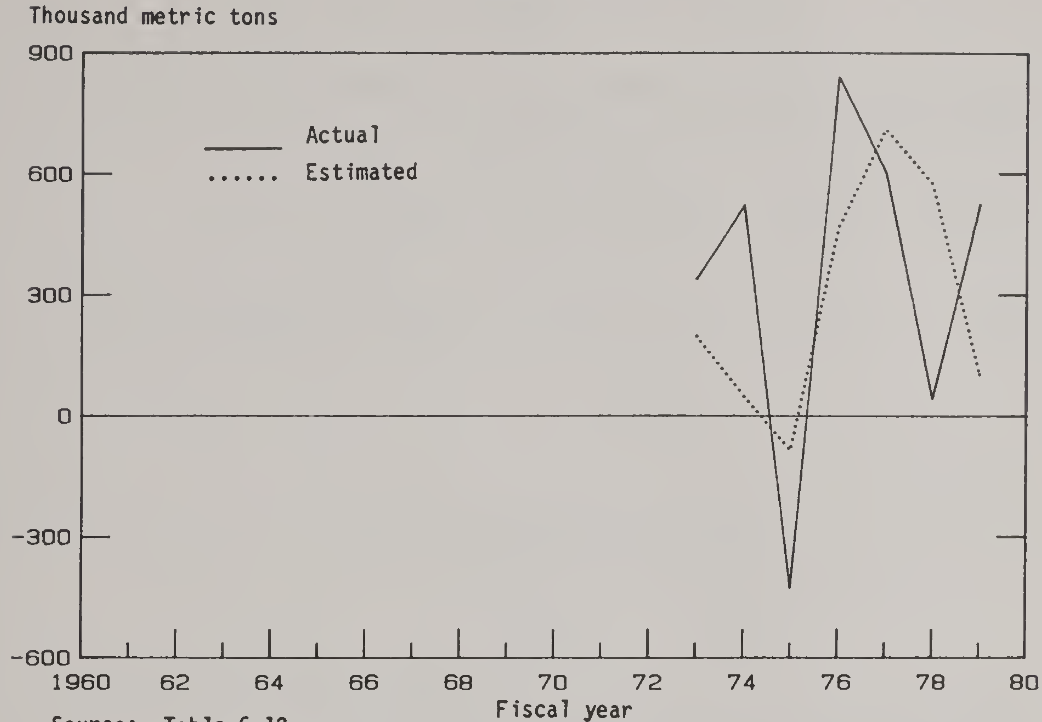
Source: Table 6.11

Table 6.11--Actual and estimated additions to stocks of other coarse grains

Fiscal year	Actual value	Static estimation			Dynamic estimation		
		Estimate	Residual	Residual / actual	Estimate	Residual	Residual / actual
	-- Thousand metric tons --			Percent	Thousand metric tons		Percent
1972	-161	--	--	--	--	--	--
1973	167	90	77	46	62	105	63
1974	135	127	8	6	32	103	76
1975	-12	-63	51	-425	5	-17	142
1976	264	190	74	28	115	149	56
1977	78	143	-65	-83	164	-86	-110
1978	-62	31	-93	150	137	-199	321
1979	74	127	-53	-72	43	31	42
Mean absolute value:			60	116		99	116
Root mean square:			65	177		115	146

Sources: Calculated from Table 6.1 and model estimates.

Figure 6.11
Actual and Estimated Year-to-Year Changes in
Food Plus Feed Consumption of Other Coarse Grains in Japan



Source: Table 6.12

Table 6.12--Actual and estimated annual change in food plus feed consumption of other coarse grains

Fiscal year	Actual value	Estimated value	Residual	Residual / actual
	-- Thousand metric tons --			Percent
1973	340	197	143	42
1974	522	50	472	90
1975	-429	-86	-343	80
1976	839	465	374	45
1977	602	710	-108	-18
1978	41	573	-532	-1,298
1979	524	102	422	81
		Mean absolute value:	342	236
		Root mean square:	373	494

Sources: Calculated from Table 6.1 and model estimates.

$$\begin{aligned} JPLQTWHC = & -31.427642 + 0.017873\ YEAR \\ & \pm 6.437098 \quad \pm 0.003263 \\ & (4.882) \qquad (5.477) \\ & 0.04\% \qquad 0.01\% \end{aligned}$$

Adjusted R^2 = 69.04 percent for 14 observations (JFY 1966-79)
Durbin-Watson statistic = 1.127
Autocorrelation of residuals = 0.332

JPLQTWHC = Japan, logarithm of net imports of wheat, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1966 to 1979)

and:

$$\begin{aligned} JPLQTCNC = & -125.143 + 0.065545\ YEAR \\ & \pm 21.647 \quad \pm 0.010958 \\ & (5.781) \qquad (5.982) \\ & 0.12\% \qquad 0.10\% \end{aligned}$$

Adjusted R^2 = 83.24 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 1.841
Autocorrelation of residuals = 0.063

JPLQTCNC = Japan, logarithm of net imports of corn, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1972 to 1979)

and:

$$\begin{aligned} JPLQTCGC = & -76.021448 + 0.040559\ YEAR \\ & \pm 16.661043 \quad \pm 0.008434 \\ & (4.563) \qquad (4.809) \\ & 0.38\% \qquad 0.30\% \end{aligned}$$

Adjusted R^2 = 75.97 percent for 8 observations (JFY 1972-79)
Durbin-Watson statistic = 3.021
Autocorrelation of residuals = -0.444

JPLQTCGC = Japan, logarithm of net imports of other coarse grains, fiscal year (kilograms per capita)

YEAR = Japanese fiscal year (values from 1972 to 1979)

A set of identities transforms these regression results into estimates of net exports measured in thousand metric tons:

```
JPQTWHFY  =  - ROUND( JPPOPFY * EXP(JPLQTWHF) / 1000 )

JPQTCNFY  =  - ROUND( JPPOPFY * EXP(JPLQTCNF) / 1000 )

JPQTCGFY  =  - ROUND( JPPOPFY * EXP(JPLQTCGF) / 1000 )
```

<u>where</u>:

* indicates multiplication

EXP is the exponentiation (e^x) operator

ROUND(x) rounds off "x" to the nearest integer

<u>and where</u>:

JPQTaaFY = Japan, net exports of aa, fiscal year (thousand metric tons); with aa from the list:

- WH = wheat
- CN = corn
- CG = other coarse grains

JPLQTaaF = Japan, logarithm of net imports of aa, fiscal year (kilograms per capita); with aa defined as above

JPPOPFY = Japan, population on October 1 (thousands)

The final step is to calculate the mean absolute value and the root mean square of the error terms for each series of net export estimates. In Table 6.13, these summary error statistics are compared to their equivalents from the full model. Despite the extreme simplicity of the equations for net trade per capita, they produce somewhat more accurate estimates than does the full model. 3/

If one is only interested in projecting net trade, then simple reduced-form equations may well do a slightly better job than the full model; and they require minimal effort. The clear advantage of the Japanese Grains Model is that it permits analyzing various "what if" and policy questions which cannot be answered by reference to a time trend.

1/ In the accounting for this model, "food use" is broadly defined to include industrial processing and wastage.

2/ Gross rice imports, unlike the other rice categories in the Japanese food balance sheets, are measured on a milled basis. But as explained in the first note to Chapter Two, the effect of this discrepancy is negligible.

3/ Time trends for total net imports also are slightly more accurate than the full model. Compared to the time trends for per capita net imports reported in Table 6.13, the time trends for total net imports estimate past corn trade a little more accurately, but estimate past wheat trade and other coarse grain trade a little less accurately.

Table 6.13--Average error terms from net trade estimates

Grain	Source of estimate	Residual: Mean absolute value	Residual: Root mean square	Residual / actual: Mean absolute value	Residual / actual: Root mean square
		Thousand metric tons		---- Percent ----	
Wheat	Model	220	249	4.6	5.3
	Trend	167	228	3.3	4.6
Corn	Model	446	551	5.1	6.0
	Trend	427	504	5.0	6.1
Other coarse grains	Model	330	392	4.8	5.7
	Trend	285	311	4.3	4.8

Sources: Calculated from model estimates as reported in Tables 6.4 to 6.6, and from time trend equations as reported in text.

CHAPTER SEVEN

POLICIES

SUMMARY

Since the late sixties, a central concern of Japanese agricultural policy has been what to do about rice accumulating in government stockpiles as a result of an all too successful price support program. The government's responses have been to lower the level or at least dampen the growth rate of the real supply price for rice; to increase the real supply prices for wheat and barley; to pay farmers not to grow rice on paddy land (the so-called rice diversion payment); to subsidize rice exports; and to subsidize the use of rice as feed.

According to this model, the principal determinant of Japanese crop policies is excess rice production, averaged over the previous 6 years. Here excess production is defined as Japanese rice production net of seed used, minus food demand. (A negative value for excess production occurs when domestic supply net of seed used is not sufficient to meet food demand.) The explanatory variable used in policy equations, JPQERIF6, is formally defined as follows:

<u>Identities</u>:

[79] JPQERIFY = JPQPRIFY - JPQDRIFY

[80] JPQERIF6 = ROUND([LAG1(JPQERIFY) + LAG2(JPQERIFY) + LAG3(JPQERIFY) + LAG4(JPQERIFY) + LAG5(JPQERIFY) + LAG6(JPQERIFY)] / 6)

<u>where</u>:

ROUND(x) rounds off "x" to the nearest integer

LAGn(x) is the value of "x" lagged by "n" years

<u>and where</u>:

JPQERIFY = Japan, excess of rice production net of seed used over rice food demand, fiscal year (thousand metric tons, brown basis)

JPQPRIFY = Japan, rice production net of seed used, fiscal year (thousand metric tons, brown basis)

JPQDRIFY = Japan, rice used as food, fiscal year (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

Another explanatory variable is the logarithm of the ratio of the rice supply price to the rice trade price, lagged by 1 year.

Identity:

[81] JPLPSTR1 = LAG1(LOG(JPPSRIR / JPPTRIR))

where:

LOG is the natural logarithm operator

and where:

JPLPSTR1 = Japan, logarithm of ratio: (rice supply price) / (rice trade price), previous year

JPPSRIR = Japan, rice supply price (1970 yen per kilogram)

JPPTRIR = Japan, trade price for rice, 5 percent broken, f.o.b. Bangkok (1970 yen per kilogram)

Four behavioral equations are used to predict supply prices and the rice diversion payment. All are based on regressions over the period 1969-79, because 1969 was when the government started implementing surplus reduction policies like the rice diversion payment. The mathematical equations below may be described verbally as follows: The real price of rice is primarily a function of the extent to which rice production exceeded market demand during the past 6 years, and secondarily a function of the extent to which the domestic price exceeded the world price during the past 1 year. The greater the past excess production, or the higher the past ratio of domestic to world price, the stronger is the downwards pressure on the current price for rice. The price of wheat follows a "step" pattern, with real prices since 1977 being about one-third higher than real prices through 1976. Aside from this jump, much smaller fluctuations in wheat prices tend to parallel fluctuations in rice prices. The ratio of the wheat price to the barley price is 1.14 through 1976 and 1.1 since 1977. Rice diversion payments are a function of excess rice production during the previous 6 years (as past excess production rises, the diversion payment increases at an accelerating rate). More precisely, the model specifies:

Behavioral (Policy) Equations:

[82] JPLPSRI = 5.048567 - 0.000076446142 * JPQERIF6
- 0.081751681 * JPLPSTR1

[83] JPLPSWH = 2.472082 + 0.29256536 * FROM1977 + 0.31981717 * JPLPSRI

[84] JPPSBAR = (1-FROM1977) * JPPSWHR / 1.14 + FROM1977 * JPPSWHR / 1.1

[85] JPLDPRI = 5.168680 + 0.00062983556 * JPQERIF6

Identities:

[86] JPPSRIR = EXP(JPLPSRI)

[87] JPPSWHR = EXP(JPLPSWH)

[88] JPDPRIR = EXP(JPLDPRI)

where:

$*$ indicates multiplication

EXP is the exponentiation (e^x) operator

and where:

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

JPLDPRI = Japan, logarithm of rice diversion payment (thousands of 1970 yen per hectare)

JPPSWHR = Japan, wheat supply price (1970 yen per kilogram)

JPPSBAR = Japan, barley supply price (1970 yen per kilogram)

JPDPRIR = Japan, rice diversion payment (thousands of 1970 yen per hectare)

FROM1977 = Dummy variable (equals 0 through 1976; equals 1 since 1977)

In the absence of government intervention, virtually no rice is exported and very little rice is used as feed. Another policy variable, therefore, is the sum of rice exports plus feed use, which is essentially the amount of surplus rice gotten rid of through government subsidies. The model uses the following equation (derived from a nonlinear regression over the years 1969-79) to predict rice feed use plus exports as a rapidly increasing function of past excess rice production:

Behavioral (Policy) Equation:

[89] JPQFXRIF = ROUND(33.30582914 * EXP(0.0036978365 * JPQERIF6))

where:

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

Because the rules governing the allocation of rice between subsidized feed and subsidized exports changed in 1980 and 1984, no attempt was made to simulate the allocation process over the period 1969-79. Instead, the model allocates the simulated total of rice feed plus gross exports in the same proportions as the actual ratio of rice feed to rice exports. In the identities below, JPRATIO is a true value, while all other variables have simulated values.

Identities:

[90] JPQXRIFY = JPRATIO * JPQFXRIF

[91] JPQFRIFY = JPQFXRIF - JPQXRIFY

where:

JPQXRIFY = Japan, rice gross exports, fiscal year (thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year (thousand metric tons, brown basis)

JPRATIO = Japan, ratio: (rice gross exports) / (rice feed + rice gross exports), fiscal year

The rules governing the future allocation of surplus rice disposal between rice exports and rice feed are modeled in Chapter Eight, where JPRATIO becomes, in effect, an endogenous policy variable.

Rice imports were small and erratic during the period under study. To simulate net trade, the model sets rice gross imports equal to their average level over 1969-79.

Behavioral (Policy) Equation:

[92] JPQMRIFY = 33

Identity:

[93] JPQTRIFY = JPQXRIFY - JPQMRIFY

where:

JPQMRIFY = Japan, rice gross imports, fiscal year (thousand metric tons, brown basis)

JPQTRIFY = Japan, rice net exports, fiscal year (thousand metric tons, brown basis)

REVIEW OF DATA

This section of the model portrays how the Japanese government implements various agricultural policies, a process which up till now has been taken for granted. These policy variables, listed in Table 7.1, are the real supply prices of rice, wheat, and barley, the diversion payment for rice, and the quantity of rice used as feed or exported. The model does not simulate demand prices, because (as reported in Chapter Three) Japanese food grain consumption is not significantly sensitive to price.

INSTITUTIONAL BACKGROUND

Rice dominates Japan's agriculture. In fiscal 1979, after more than a decade of government efforts to reduce rice production, it still provided more than three-fifths of the cash receipts for 57 percent of Japan's farm households, and more than four-fifths of the cash receipts for 47 percent of farm

Table 7.1--Japanese policy variables

Fiscal year	Real supply prices: Rice	Real supply prices: Wheat	Real supply prices: Barley	Real rice diversion payment	Rice used as feed or exported
	1970 yen per kilogram			Thousands of 1970 yen/ha.	Thousand metric tons
1960	113.1	62.3	55.2	0	20
1961	112.7	62.3	54.6	0	20
1962	116.7	61.5	53.9	0	20
1963	120.8	59.4	52.0	0	32
1964	132.3	59.4	52.0	0	20
1965	134.1	58.4	51.2	0	20
1966	142.7	59.7	52.3	0	28
1967	149.8	59.9	52.5	0	26
1968	152.2	59.7	52.3	0	61
1969	142.9	57.7	50.6	212	466
1970	135.9	57.2	50.1	350	1,059
1971	132.7	57.3	50.3	375	2,349
1972	132.0	56.6	49.6	357	1,724
1973	130.8	55.6	48.7	307	926
1974	141.7	58.4	51.2	252	284
1975	146.7	58.3	51.1	228	12
1976	142.9	57.2	50.1	209	15
1977	139.3	77.4	70.3	196	109
1978	135.4	76.4	69.4	260	9
1979	129.2	74.6	67.8	248	875

Notes: The figures for prices and diversion payments shown here, unlike those used in model estimation, are rounded.

Rice weights are measured on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 2.15 (for supply prices), Table 2.16 (for diversion payments), and Table 2.1 (for rice feed plus exports).

households. 1/ Rice is also the dominant cereal in the Japanese diet: in 1979, it accounted for about 70 percent of the calories from cereals, and 30 percent of the calories from all food. 2/

Until the late sixties, Japanese policy was preoccupied with getting enough rice. Memories of the acute food shortages during the Second World War were still vivid. Moreover, Japan had been a net importer of rice since 1900. 3/ During the fifties, the government sought to increase rice production through technical means like research and extension services; but it kept rice prices low, to allow cheap wages and thereby foster industrial development. During the sixties, when rice was no longer a very important component of workers' budgets, the government rapidly increased its support prices, both to encourage production and to improve farm incomes. By 1966, the government rice purchase price was double the world trade price; 4/ and domestic supply exceeded demand for the first time since 1899. The government continued to import substantial amounts of rice for the following two years, to build up a buffer stockpile. But as local production kept increasing while per capita food demand was steadily declining, the Japanese Food Agency found itself burdened with ever growing stockpiles of unsalable rice.

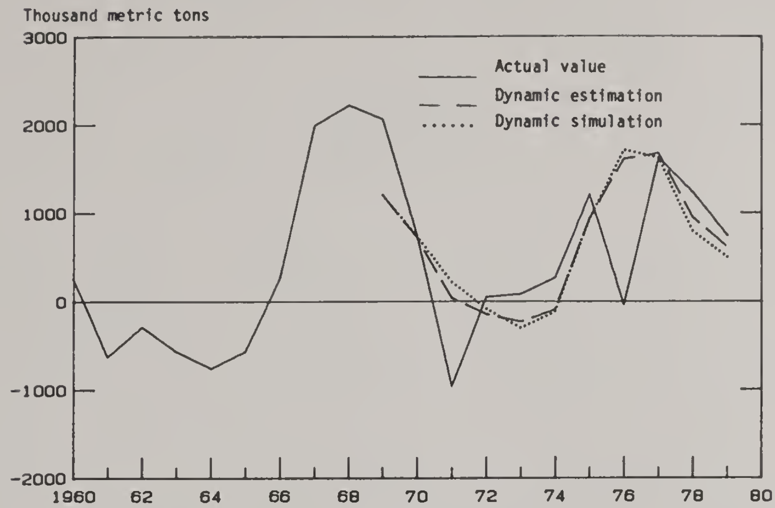
In 1969, the government embarked on a series of policies designed to reduce rice production, mainly by persuading farmers to grow something else. The purchase prices for wheat and barley were increased relative to the purchase price for rice. Though the government continued to raise the nominal purchase price for rice, in most years its growth was kept below the rate of inflation, so that the real price declined. A diversion payment scheme was adopted, whereby farmers were paid a fixed fee per hectare for diverting paddy land to other uses. To get rid of accumulated stocks of old rice, the government subsidized its use as feed and as food-aid exports. 5/

MODELING APPROACH

Any economic model is a greatly stylized, simplified version of reality. This particular model makes the assumption that the most important factor motivating Japanese grains policies since 1969 has been the excess of rice supply over market rice demand. "Excess rice production" is defined as production net of seed, minus food consumption. (A negative value for excess production occurs when domestic supply is insufficient to meet domestic seed and food demand.) In theory, unsubsidized rice feed should be subtracted from production, along with seed and food, to calculate excess production. In practice, the amount of unsubsidized rice feed is so minuscule--about 6 thousand metric tons in recent years--that it can be ignored. Because policy makers react to events only gradually, and because they realize that supply is subject to random fluctuations caused by factors like weather, what influences policies is the average level of excess rice production over a span of past years. Various lag structures were tested. The average quantity of excess rice production during the previous 6 years was ultimately selected as the best predictor of Japanese policies. 6/

Actual, estimated, and simulated values of excess rice production are shown in Tables 7.2 and 7.3 and in Figures 7.1 and 7.2. A few technical notes are in order. Excess production is of course a function of production, which equals yield times area, which in turn are influenced by lagged prices, lagged yields, and lagged areas. Dynamically simulated excess rice production is calculated on the basis of actual prices, areas, and yields dating from years

Figure 7.1
Actual, Estimated, and Simulated
Excess Rice Production in Japan



Source: Table 7.2

Table 7.2--Actual, estimated, and simulated excess rice production

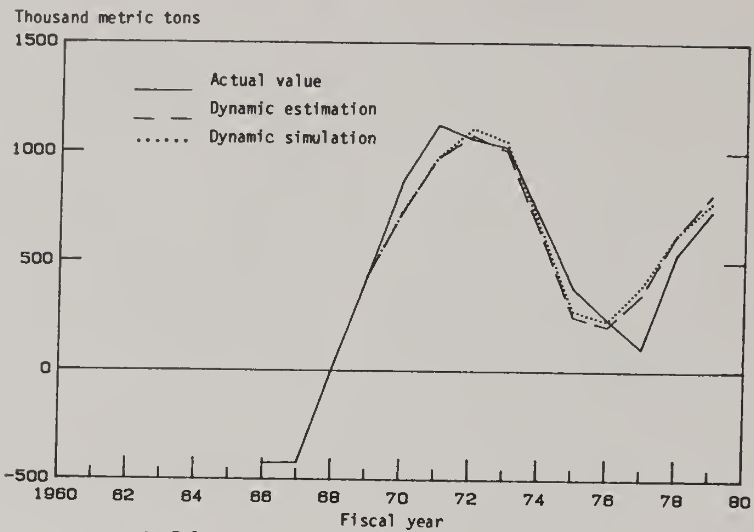
Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	---- Thousand metric tons ----			Percent	Thousand metric tons		Percent
1960	260	--	--	--	--	--	--
1961	-623	--	--	--	--	--	--
1962	-286	--	--	--	--	--	--
1963	-566	--	--	--	--	--	--
1964	-757	--	--	--	--	--	--
1965	-564	--	--	--	--	--	--
1966	270	--	--	--	--	--	--
1967	1,996	--	--	--	--	--	--
1968	2,224	--	--	--	--	--	--
1969	2,064	1,205	859	42	1,205	859	42
1970	763	726	37	5	743	20	3
1971	-956	38	-994	104	219	-1,175	123
1972	53	-145	198	374	-84	137	258
1973	87	-229	316	363	-304	391	449
1974	272	-89	361	133	-116	388	143
1975	1,211	935	276	23	926	285	24
1976	-35	1,613	-1,648	4,709	1,711	-1,746	4,989
1977	1,621	1,676	-55	-3	1,624	-3	-0
1978	1,233	947	286	23	791	442	36
1979	747	617	130	17	501	246	33
	Mean absolute value:	469	527			517	554
	Root mean square:	667	1,429			728	1,513

Notes: Excess rice production is defined as domestic supply minus seed and food demand.

Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Calculated from data in Table 2.1, model estimates, and model simulations.

Figure 7.2
Actual, Estimated, and Simulated Average of
Excess Rice Production During Previous Six Years



Source: Table 7.3

Table 7.3--Actual, estimated, and simulated average of excess rice production during previous six years

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1966	-423	--	--	--	--	--	--
1967	-421	--	--	--	--	--	--
1968	16	--	--	--	--	--	--
1969	434	434	0	0	434	0	0
1970	872	729	143	16	729	143	16
1971	1,126	976	150	13	979	147	13
1972	1,060	1,077	-17	-2	1,110	-50	-5
1973	1,024	1,007	17	2	1,051	-27	-3
1974	706	637	69	10	667	39	6
1975	381	251	130	34	277	104	27
1976	238	206	32	13	231	7	3
1977	105	354	-249	-237	392	-287	-273
1978	535	627	-92	-17	626	-91	-17
1979	732	809	-77	-11	772	-40	-5
Mean absolute value:			89	32		85	33
Root mean square:			114	73		117	83

Notes: Excess rice production is defined as domestic supply minus seed and food demand.

Estimated and simulated averages are based on lagged actual values from years through 1968, and on lagged estimated or simulated values from years since 1969.

Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Source: Calculated from figures in Table 7.2.

through 1968, and simulated prices, areas, and yields dating from years since 1969. Dynamically estimated excess rice production is calculated on the basis of actual areas and yields dating from years through 1968, estimated areas and yields dating from years since 1969, and actual prices in all years. 7/

Along with excess rice production, several other variables influence policies. Trade prices have a restraining effect on domestic prices. The price of rice influences wheat and barley prices.

Because sweeping changes in Japan's agricultural policies were introduced in 1969, this model portrays the behavior of policy variables only since that year. The rules governing the allocation of surplus rice disposal between feed and exports were changed in 1980, and again in 1984. Therefore this chapter makes no attempt to explain the ratio of rice feed to exports between 1969 and 1979. Instead, each year's simulated total of rice feed plus exports is split in the same proportion as that year's actual ratio of rice feed to exports. This allows calculation of simulated rice net trade, simulated corn feed usage, and so on. In the next chapter on projections, an additional behavioral equation allocates surplus rice disposal between exports and feed.

RICE SUPPLY PRICE

The official purchase price for rice is modeled as a function of past excess rice production and the trade price for rice. Because the government usually determines the purchase price early in the calendar year, the previous year's trade price is assumed to form a basis for decisions. Two measures of the trade price were tested: the logarithm of the real trade price in the previous year, and the logarithm of the ratio of the domestic supply price to the trade price in the previous year. The latter measure proved to have slightly more explanatory power. Thus the behavioral equation used in the model is:

$$
\begin{array}{llll}
JPLPSRI = & 5.048567 & - \; 0.000076446142 \; JPQERIF6 & - \; 0.081751681 \; JPLPSTR1 \\
 & \pm\, 0.012658 & \pm\, 0.000011154774 & \pm\, 0.011384399 \\
 & (398.828) & (6.853) & (7.181) \\
 & 0.01\% & 0.01\% & 0.01\%
\end{array}
$$

Adjusted R^2 = 91.92 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 1.897
Autocorrelation of residuals = -0.210

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPLPSTR1 = Japan, logarithm of ratio: (rice supply price) / (rice trade price), previous year

This equation implies that a 1 percent reduction in the real price for rice will be induced either by a 12 percent increase in the ratio of the domestic price to the trade price during the previous year, or by a 131 thousand ton increase in the average level of excess rice production during the previous 6 years. 8/ The quantity 131 thousand metric tons equals a bit more than 1 percent of current Japanese rice production or consumption.

An obvious identity transforms the regression results into yen per kilogram:

JPPSRIR = EXP(JPLPSRI)

where:

EXP is the exponentiation (e^x) operator

JPPSRIR = Japan, rice supply price (1970 yen per kilogram)

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

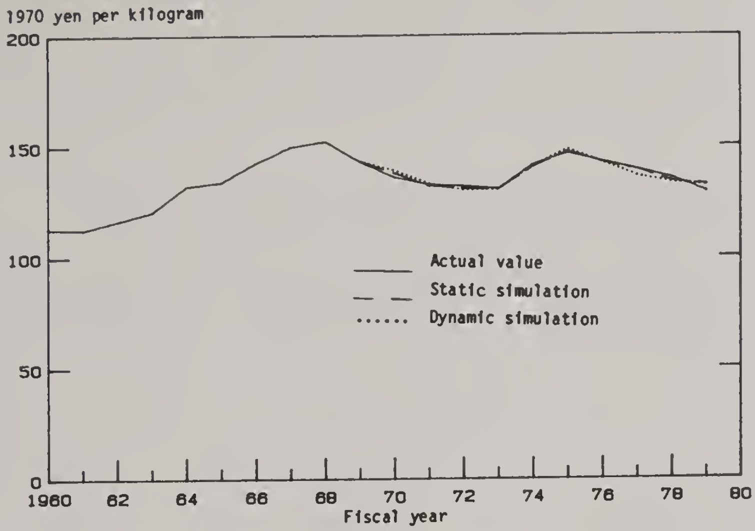
Table 7.4 and Figure 7.3 compare actual and simulated values for the rice supply price. In general, static simulations are based on the actual values of all lagged variables, whereas dynamic simulations are based on the simulated values of lagged endogenous and policy variables, whenever simulated values are available. 9/ In this case, the dynamic simulations are calculated using the simulated values of the previous 6 years' excess rice production, along with the ratio of the simulated value of the previous year's rice supply price to the actual value of the previous year's rice trade price (which is an exogenous variable). However, actual values are used for all lagged variables dating from years before the 1969 beginning of the simulation period.

WHEAT AND BARLEY SUPPLY PRICES

It is clear from Table 7.5 that Japanese policy makers jointly determine the prices of wheat and barley, for the ratio of the wheat price to the barley price has remained fixed for many years. (Indeed, it has been fixed to one more decimal place than shown in the table.) Thus determining either the wheat price or the barley price in practice determines both. In this model, the wheat price is determined first, mainly because trade price data are more readily available for wheat than for barley.

The dominant feature of wheat price movements during the period under study is an upwards jump between 1976 and 1977, as is evident from Figure 7.4 below. Thus a dummy variable, equal to 0 through 1976 and and equal to 1 since 1977, was included in all regressions for the price of wheat. 10/ Dummy variables often (as in this case) serve as a cheap substitute for an explanation of the underlying cause, and often (as in this case) there is no good way to determine the appropriate value for a dummy variable in future years. However, the rare and abrupt nature of the change in wheat and barley prices leaves no choice but to use a dummy variable--and to realize that the model cannot predict the timing of the next abrupt price change. 11/

Figure 7.3
Actual and Simulated Price of Rice in Japan



Source: Table 7.4

Table 7.4--Actual and simulated price of rice

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- 1970 yen per kilogram ---			Percent	1970 yen per kilogram		Percent
1960	113.1	--	--	--	--	--	--
1961	112.7	--	--	--	--	--	--
1962	116.7	--	--	--	--	--	--
1963	120.8	--	--	--	--	--	--
1964	132.3	--	--	--	--	--	--
1965	134.1	--	--	--	--	--	--
1966	142.7	--	--	--	--	--	--
1967	149.8	--	--	--	--	--	--
1968	152.2	--	--	--	--	--	--
1969	142.9	143.3	-0.5	-0.3	143.3	-0.5	-0.3
1970	135.9	137.8	-1.9	-1.4	139.3	-3.4	-2.5
1971	132.7	132.1	0.6	0.5	133.3	-0.6	-0.5
1972	132.0	130.9	1.1	0.9	130.3	1.7	1.3
1973	130.8	130.7	0.0	0.0	130.6	0.2	0.1
1974	141.7	140.6	1.1	0.8	141.1	0.7	0.5
1975	146.7	147.4	-0.6	-0.4	148.6	-1.9	-1.3
1976	142.9	142.7	0.2	0.2	142.6	0.2	0.2
1977	139.3	139.3	-0.0	-0.0	136.3	3.0	2.1
1978	135.4	133.9	1.5	1.1	133.2	2.2	1.6
1979	129.2	132.4	-3.2	-2.5	132.1	-3.0	-2.3
	Mean absolute value:		1.0	0.7		1.6	1.2
	Root mean square:		1.3	1.0		1.9	1.4

Note: Simulated value plus residual may not exactly equal actual value, due to rounding.

Sources: Table 7.1 and model simulations.

Table 7.5--Ratios of grain supply prices

Fiscal year	Rice price / Wheat price	Rice price / Barley price	Wheat price / Barley price
		Ratio	
1960	1.82	2.05	1.13
1961	1.81	2.06	1.14
1962	1.90	2.16	1.14
1963	2.03	2.32	1.14
1964	2.23	2.54	1.14
1965	2.30	2.62	1.14
1966	2.39	2.73	1.14
1967	2.50	2.86	1.14
1968	2.55	2.91	1.14
1969	2.48	2.82	1.14
1970	2.38	2.71	1.14
1971	2.31	2.64	1.14
1972	2.33	2.66	1.14
1973	2.35	2.68	1.14
1974	2.43	2.77	1.14
1975	2.52	2.87	1.14
1976	2.50	2.85	1.14
1977	1.80	1.98	1.10
1978	1.77	1.95	1.10
1979	1.73	1.90	1.10

Source: Calculated from data in Table 2.15.

The logarithm of the wheat supply price was regressed on the FROM1977 dummy variable, and on various combinations of the logarithm of the supply price for rice, the logarithm of the previous year's trade price for wheat, and the logarithm of the previous year's ratio of the wheat supply price to the wheat trade price. The set of tested equations are discussed further in the compendium of regression equations at the end of this chapter. The equation selected for the model is shown here:

JPLPSWH	=	2.472082	+ 0.29256536 FROM1977	+ 0.31981717 JPLPSRI
		$\pm$ 0.373851	$\pm$ 0.00687926	$\pm$ 0.07586210
		(6.612)	(42.529)	(4.216)
		0.02%	0.01%	0.29%

Adjusted R^2 = 99.47 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 2.389
Autocorrelation of residuals = -0.234

JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

FROM1977 = Dummy variable (equals 0 through 1976; equals 1 since 1977)

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

Translated from mathematical terms into English, the equation states that when Japanese policy makers change the rice price by 1 percent, they change the wheat price by 0.3 percent in the same direction; and that independently of this, policy makers increased the price of wheat by one-third between 1976 and 1977. 12/

Most of the variance in the wheat price variable is "explained" by the dummy variable. Thus a regression of the logarithm of the wheat supply price on FROM1977 alone produces an adjusted R^2 statistic of 98.48 percent. After the influence of the step increase between 1976 and 1977 has been statistically removed, the rice price variable explains nearly 60 percent of the remaining year-to-year variance in the wheat price variable. (A more technical analysis of these points is given in the last section of this chapter.)

The obvious identity converts the logarithm of the wheat supply price into its price in yen per kilogram:

JPPSWHR = EXP(JPLPSWH)

where:

EXP is the exponentiation (e^x) operator

JPPSWHR = Japan, wheat supply price (1970 yen per kilogram)

JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

The ratios shown in Table 7.5 are then used to derive the barley supply price from the wheat supply price:

JPPSBAR = (1-FROM1977) * JPPSWHR / 1.14 + FROM1977 * JPPSWHR / 1.1

<u>where</u>:

* indicates multiplication

JPPSBAR = Japan, barley supply price (1970 yen per kilogram)

JPPSWHR = Japan, wheat supply price (1970 yen per kilogram)

FROM1977 = Dummy variable (equals 0 through 1976; equals 1 since 1977)

Table 7.6 and Figure 7.4 show actual and simulated wheat supply prices. Table 7.7 and Figure 7.5 display actual and simulated barley supply prices.

RICE DIVERSION PAYMENT

The logarithm of the rice diversion payment is taken as a function of the average amount of excess rice production during the previous 6 years. Obviously, the following regression equation cannot be applied to years before 1969, when there was no rice diversion program.

$$\begin{array}{lll} JPLDPRI = & 5.168680 & + \ 0.00062983556 \ JPQERIF6 \\ & \pm\ 0.056881 & \pm\ 0.00007753460 \\ & (90.868) & (8.123) \\ & 0.01\% & 0.01\% \end{array}$$

Adjusted R^2 = 86.66 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 1.795
Autocorrelation of residuals = -0.058

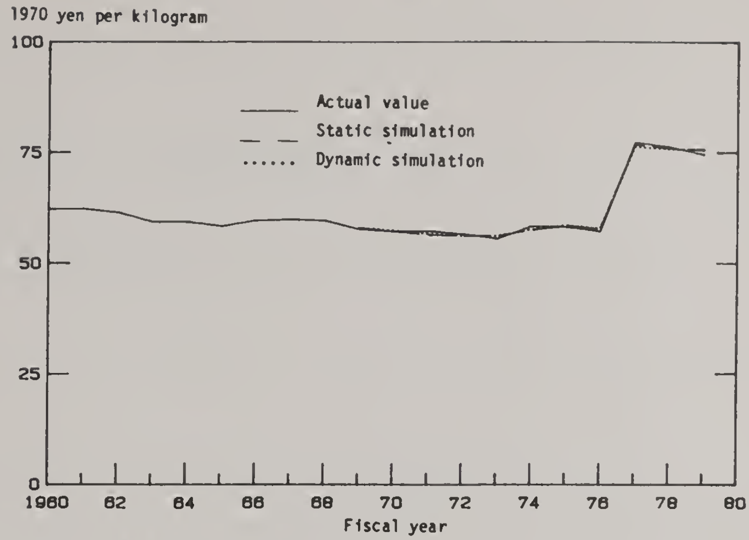
JPLDPRI = Japan, logarithm of rice diversion payment (thousands of 1970 yen per hectare)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

This regression equation implies that an increase of 16 thousand metric tons in average excess rice production during the past 6 years would induce a 1 percent rise in the rice diversion payment. 13/

The usual identity converts the regression results into thousands of 1970 yen per hectare:

Figure 7.4
Actual and Simulated Price of Wheat in Japan



Source: Table 7.6

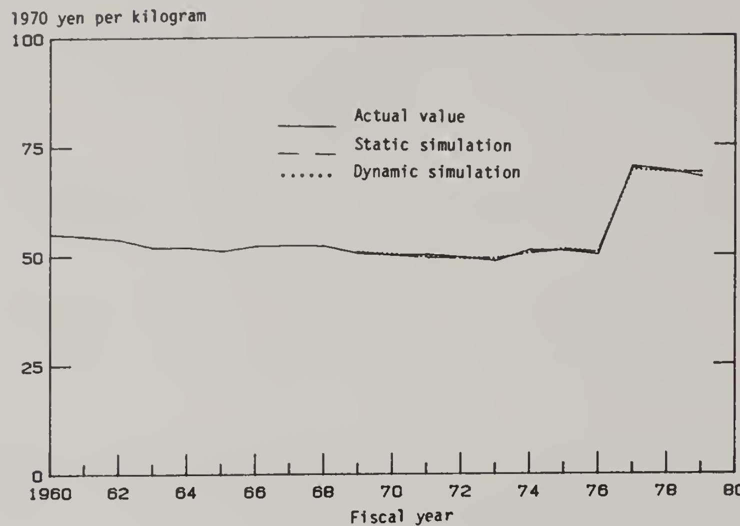
Table 7.6--Actual and simulated price of wheat

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	-- 1970 yen per kilogram --			Percent	1970 yen per kilogram		Percent
1960	62.3	--	--	--	--	--	--
1961	62.3	--	--	--	--	--	--
1962	61.5	--	--	--	--	--	--
1963	59.4	--	--	--	--	--	--
1964	59.4	--	--	--	--	--	--
1965	58.4	--	--	--	--	--	--
1966	59.7	--	--	--	--	--	--
1967	59.9	--	--	--	--	--	--
1968	59.7	--	--	--	--	--	--
1969	57.7	58.0	-0.3	-0.5	58.0	-0.3	-0.5
1970	57.2	57.3	-0.1	-0.1	57.4	-0.3	-0.5
1971	57.3	56.5	0.9	1.5	56.6	0.7	1.2
1972	56.6	56.3	0.3	0.6	56.2	0.4	0.7
1973	55.6	56.3	-0.7	-1.2	56.3	-0.7	-1.2
1974	58.4	57.6	0.8	1.4	57.7	0.8	1.3
1975	58.3	58.5	-0.2	-0.4	58.6	-0.4	-0.7
1976	57.2	57.9	-0.7	-1.2	57.9	-0.7	-1.2
1977	77.4	77.0	0.4	0.6	76.4	1.0	1.3
1978	76.4	76.0	0.4	0.5	75.9	0.5	0.6
1979	74.6	75.7	-1.1	-1.5	75.7	-1.1	-1.4
		Mean absolute value:	0.5	0.9		0.6	1.0
		Root mean square:	0.6	1.0		0.7	1.0

Note: Simulated value plus residual may not exactly equal actual value, due to rounding.

Sources: Table 7.1 and model simulations.

Figure 7.5
Actual and Simulated Price of Barley in Japan



Source: Table 7.7

Table 7.7--Actual and simulated price of barley

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	-- 1970 yen per kilogram --			Percent	1970 yen per kilogram		Percent
1960	55.2	--	--	--	--	--	--
1961	54.6	--	--	--	--	--	--
1962	53.9	--	--	--	--	--	--
1963	52.0	--	--	--	--	--	--
1964	52.0	--	--	--	--	--	--
1965	51.2	--	--	--	--	--	--
1966	52.3	--	--	--	--	--	--
1967	52.5	--	--	--	--	--	--
1968	52.3	--	--	--	--	--	--
1969	50.6	50.9	-0.3	-0.5	50.9	-0.3	-0.5
1970	50.1	50.2	-0.1	-0.2	50.4	-0.3	-0.5
1971	50.3	49.5	0.7	1.4	49.7	0.6	1.1
1972	49.6	49.4	0.2	0.5	49.3	0.3	0.6
1973	48.7	49.4	-0.6	-1.3	49.4	-0.6	-1.3
1974	51.2	50.5	0.7	1.3	50.6	0.6	1.2
1975	51.1	51.3	-0.2	-0.5	51.4	-0.4	-0.8
1976	50.1	50.8	-0.7	-1.3	50.8	-0.7	-1.3
1977	70.3	70.0	0.3	0.5	69.5	0.8	1.2
1978	69.4	69.1	0.3	0.4	69.0	0.4	0.5
1979	67.8	68.8	-1.0	-1.5	68.8	-1.0	-1.5
	Mean absolute value:		0.5	0.9		0.5	1.0
	Root mean square:		0.5	1.0		0.6	1.0

Note: Simulated value plus residual may not exactly equal actual value, due to rounding.

Sources: Table 7.1 and model simulations.

JPDPRIR = EXP(JPLDPRI)

where:

EXP is the exponentiation (e^x) operator

JPDPRIR = Japan, rice diversion payment (thousands of 1970 yen per hectare)

JPLDPRI = Japan, logarithm of rice diversion payment (thousands of 1970 yen per hectare)

Table 7.8 and Figure 7.6 compare actual and simulated values for the rice diversion payment.

DISPOSAL OF SURPLUS RICE

For purposes of this model, the disposal of surplus rice is considered to be equivalent to rice used as feed plus gross rice exports. The government also disposed of stockpiled rice by subsidizing its use as an industrial input, for making products like rice wine. However, this program mostly caused manufacturers to use old rice in place of new rice, while the new rice they no longer purchased was added to stocks. Thus the subsidized disposal of rice for use in manufacture had little net effect on the quantities entering food balance sheet categories. It is a minor simplification of reality for this model to ignore the subsidization of surplus rice for industrial use.

Total of Rice Feed Plus Exports

Up till now, all the regressions used to derive behavioral relationships for the model have been of the form:

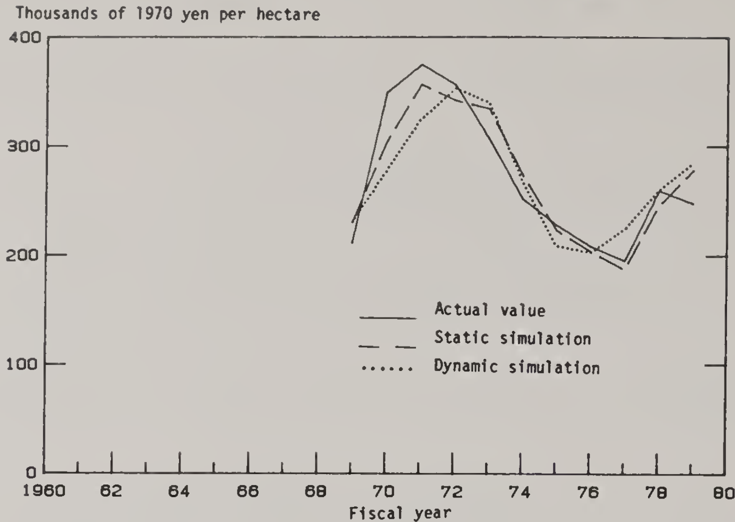
(Logarithm of explained variable) =

Linear combination of explanatory variables

Calculating that "log-linear" form of regression equation produces coefficients which minimize the sum of the squared errors in the prediction of the logarithm of the explained variable. This is equivalent to minimizing the sum of the squared percent errors in the prediction of the explained variable itself.

Usually it makes little practical difference whether errors or percent errors are minimized. The distinction is important, however, when the minimum value of an explained variable is far smaller than its maximum value--as is the case with the quantity of rice used as feed or exported. Suppose that the variable equals 6 in a first year, and 600 in a second year. In a log-linear regression, an error of 3 in the first year (a 50 percent error) would be considered just as serious as an error of 300 in the second year (also a 50 percent error). Moreover, because the sum of squared percent-error terms is being minimized, the error term of 3 in the first year would be considered four times as bad as an error of 150 in the second year (only a 25 percent error).

Figure 7.6
Actual and Simulated Japanese Rice Diversion Payment



Source: Table 7.8

Table 7.8--Actual and simulated rice diversion payment

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1969	212	231	-19	-8.9	231	-19	-8.9
1970	350	304	46	13.1	278	72	20.6
1971	375	357	18	4.9	325	50	13.3
1972	357	343	14	4.0	353	3	0.9
1973	307	335	-28	-9.0	341	-33	-10.9
1974	252	274	-22	-8.7	267	-15	-6.1
1975	228	223	5	2.1	209	19	8.3
1976	209	204	5	2.2	203	6	2.7
1977	196	188	8	4.0	225	-29	-15.0
1978	260	246	14	5.4	261	-1	-0.2
1979	248	279	-30	-12.3	286	-38	-15.1
		Mean absolute value:	19	6.8		26	9.3
		Root mean square:	22	7.7		33	11.1

Notes: There was no rice diversion payment program before 1969.
Simulated value plus residual may not exactly equal actual value, due to rounding.

Sources: Table 7.1 and model simulations.

Therefore running a regression of the form:

(Logarithm of rice used as feed or exported) =

a + b (Average past excess rice production)

produces an equation which simulates low values of rice disposal very precisely, but simulates high values of rice disposal very poorly.

A regression in the linear form:

(Rice used as feed or exported) =

a + b (Average past excess rice production)

calculates values of a and b which simulate large and small values of surplus rice disposal with equal precision. But unlike the equation associated with the log-linear regression, this equation would in some cases predict negative values for rice feed plus gross exports--which are clearly impossible.

A better solution is to start with the log-linear equation:

(Logarithm of rice used as feed or exported) =

a + b (Average past excess rice production)

and to exponentiate both sides, obtaining:

(Rice used as feed or exported) =

a' * EXP(b * (Average past excess rice production))

where * indicates multiplication, EXP(x) is the exponentiation (e^x) operator, and a' equals EXP(a). The final step is to estimate the values of a' and b using a nonlinear regression technique. The resultant equation has two desirable properties: it minimizes the sum of the squared errors in the predictions for rice feed plus exports, rather than minimizing the sum of squared percent errors; and it never predicts a negative value for rice feed plus exports when a' and b are positive. However, nonlinear regressions also have some undesirable properties. Because they are far more complicated to estimate than linear regressions, they entail much higher computer costs. More importantly, the statistical properties of nonlinear regressions are less well understood than the statistical properties of linear regressions. Thus the standard errors, t-statistics, and significance levels reported for the regression equation below are only approximations. 14/ 15/

```
JPQFXRIF  =  33.30582914  *  EXP( 0.0036978365 * JPQERIF6 )
           ± 26.68981027      ± 0.0007603082

             (1.248)            (4.864)
             23.29%             0.09%
```

Adjusted R^2 = 92.99 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 1.368
Autocorrelation of residuals = 0.156

* indicates multiplication

EXP is the exponentiation (e^x) operator

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

Built into this equation is the assumption that the government reacts mildly to small amounts of excess rice production, but accelerates its rice disposal program as the quantity of past excess rice production increases. According to the equation, if the average quantity of excess rice production during the past 6 years is zero, then 33 thousand metric tons of rice will be used as feed or exported. 16/ Levels of 120, 600, and 1,200 thousand metric tons of average excess rice production during the previous 6 years (corresponding to roughly 1 percent, 5 percent, and 10 percent of annual rice consumption or production) are predicted to induce rice surplus disposal of 52, 306, and 2,816 thousand metric tons, respectively. As a general rule, the equation implies that a 1 percent increase in surplus rice disposal will be induced by each 2.7 thousand metric ton increase in the average quantity of excess rice production during the previous 6 years. 17/

Table 7.9 and Figure 7.7 show actual and simulated surplus rice disposal. All simulated quantities are rounded off to the nearest thousand metric tons.

Allocation between Feed and Exports

As mentioned previously, the simulated total of rice feed plus exports is divided between simulated rice feed and simulated rice exports in the same proportion as the ratio of actual rice feed to actual rice exports. In the identities below, JPRATIO represents an actual value, while all other variables represent simulated values.

JPQXRIFY = JPRATIO * JPQFXRIF

JPQFRIFY = JPQFXRIF - JPQXRIFY

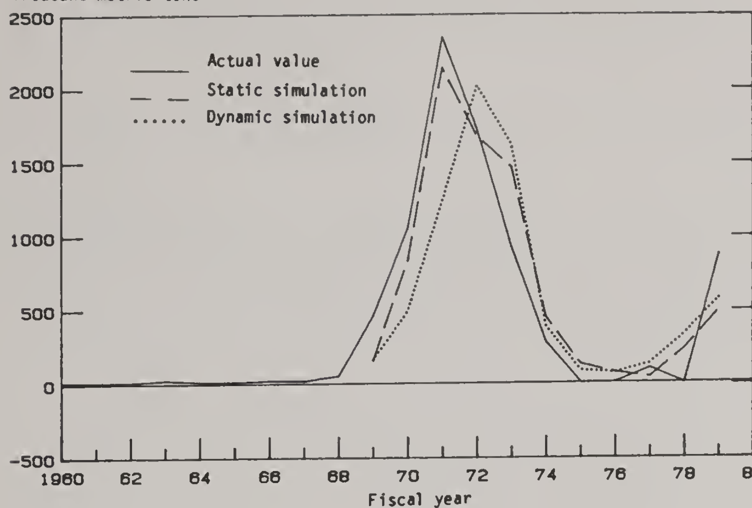
where:

* indicates multiplication

JPQXRIFY = Japan, rice gross exports, fiscal year (thousand metric tons, brown basis)

JPRATIO = Japan, ratio: (rice gross exports) / (rice feed + rice gross exports), fiscal year

Figure 7.7
Actual and Simulated Japanese Rice Used as Feed or Exported



Source: Table 7.9

Table 7.9--Actual and simulated Japanese rice used as feed or exported

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	20	--	--	--	--	--	--
1961	20	--	--	--	--	--	--
1962	20	--	--	--	--	--	--
1963	32	--	--	--	--	--	--
1964	20	--	--	--	--	--	--
1965	20	--	--	--	--	--	--
1966	28	--	--	--	--	--	--
1967	26	--	--	--	--	--	--
1968	61	--	--	--	--	--	--
1969	466	166	300	64	166	300	64
1970	1,059	837	222	21	493	566	53
1971	2,349	2,142	207	9	1,244	1,105	47
1972	1,724	1,678	46	3	2,019	-295	-17
1973	926	1,469	-543	-59	1,623	-697	-75
1974	284	453	-169	-60	392	-108	-38
1975	12	136	-124	-1,033	93	-81	-675
1976	15	80	-65	-433	78	-63	-420
1977	109	49	60	55	142	-33	-30
1978	9	241	-232	-2,578	337	-328	-3,644
1979	875	499	376	43	579	296	34
	Mean absolute value:		213	396		352	464
	Root mean square:		257	848		469	1,125

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 7.1 and model simulations.

JPQFXRIF = Japan, rice used as feed or exported, fiscal year
(thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year
(thousand metric tons, brown basis)

Actual and simulated values of rice feed are shown in Table 7.10 and Figure 7.8.

To convert gross exports into net exports (in other words, net trade), imports must be subtracted. Imports are simulated very simply as being always equal to their average level during the years 1969-79:

JPQMRIFY = 33

and this quantity is substituted into the identity:

JPQTRIFY = JPQXRIFY - JPQMRIFY

<u>where</u>:

JPQMRIFY = Japan, rice gross imports, fiscal year
(thousand metric tons, brown basis)

JPQTRIFY = Japan, rice net exports, fiscal year
(thousand metric tons, brown basis)

JPQXRIFY = Japan, rice gross exports, fiscal year
(thousand metric tons, brown basis)

Table 7.11 and Figure 7.9 compare actual and simulated rice net trade (measured as net exports).

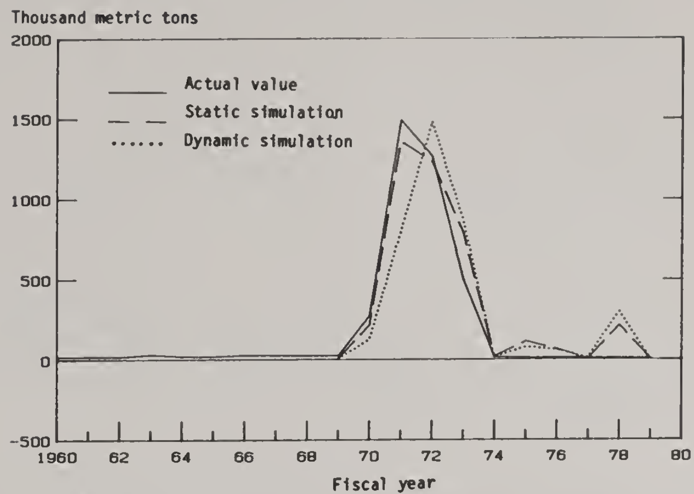
COMPLETE MODEL SIMULATION FROM 1969 THROUGH 1979

The model's ability to track the historical record for policy variables has been documented in the tables and graphs of the previous sections. This section shows how well the model simulates the past for all other variables which are influenced by government policies.

Together with the equations that predict policy variables, model simulation uses all of the equations previously derived for model estimation. To estimate the model, actual values of policy variables are substituted into the equations. To simulate the model, simulated values of policy variables are substituted into the same equations.

Food consumption is unaffected by any policy variable in this model. Thus all results from Chapter Three still apply (and are not repeated here).

Figure 7.8
Actual and Simulated Rice Used as Feed in Japan



Source: Table 7.10

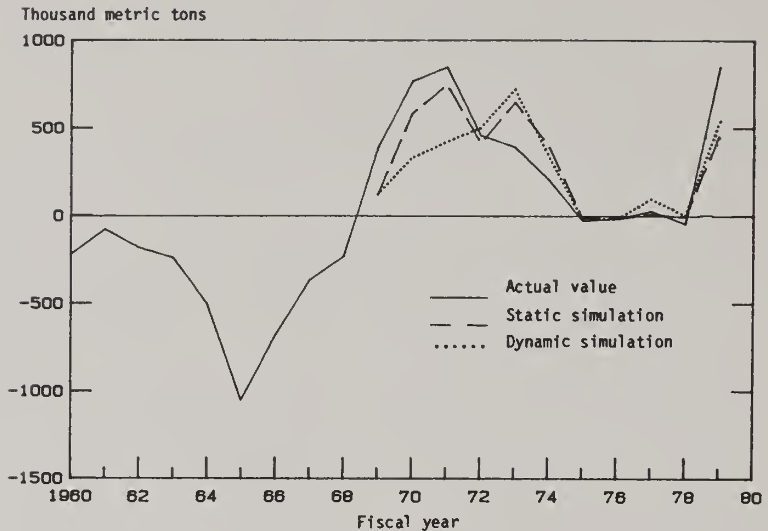
Table 7.10--Actual and simulated rice used as feed

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	20	--	--	--	--	--	--
1961	20	--	--	--	--	--	--
1962	20	--	--	--	--	--	--
1963	32	--	--	--	--	--	--
1964	20	--	--	--	--	--	--
1965	20	--	--	--	--	--	--
1966	28	--	--	--	--	--	--
1967	26	--	--	--	--	--	--
1968	26	--	--	--	--	--	--
1969	26	9	17	65	9	17	65
1970	274	217	57	21	128	146	53
1971	1,490	1,359	131	9	789	701	47
1972	1,265	1,231	34	3	1,481	-216	-17
1973	496	787	-291	-59	869	-373	-75
1974	13	21	-8	-62	18	-5	-38
1975	10	113	-103	-1,030	78	-68	-680
1976	12	64	-52	-433	62	-50	-417
1977	9	4	5	56	12	-3	-33
1978	8	214	-206	-2,575	300	-292	-3,650
1979	7	4	3	43	5	2	29
		Mean absolute value:	82	396		170	464
		Root mean square:	121	847		268	1,127

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 2.1 and model simulations.

Figure 7.9
Actual and Simulated Net Exports of Rice from Japan



Source: Table 7.11

Table 7.11--Actual and simulated net exports of rice

Fiscal year	Actual value	Static simulation: Simulated value	Static simulation: Residual	Static simulation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	-219	--	--	--	--	--	--
1961	-77	--	--	--	--	--	--
1962	-182	--	--	--	--	--	--
1963	-239	--	--	--	--	--	--
1964	-502	--	--	--	--	--	--
1965	-1,052	--	--	--	--	--	--
1966	-679	--	--	--	--	--	--
1967	-364	--	--	--	--	--	--
1968	-230	--	--	--	--	--	--
1969	392	124	268	68	124	268	68
1970	770	587	183	24	332	438	57
1971	849	750	99	12	422	427	50
1972	458	414	44	10	505	-47	-10
1973	392	649	-257	-66	721	-329	-84
1974	208	399	-191	-92	341	-133	-64
1975	-27	-10	-17	63	-18	-9	33
1976	-15	-17	2	-13	-17	2	-13
1977	29	12	17	59	97	-68	-234
1978	-44	-6	-38	86	4	-48	109
1979	848	462	386	46	541	307	36
	Mean absolute value:		137	49		189	69
	Root mean square:		184	57		248	91

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 2.1 and model simulations.

Due to the assumption that rice feed displaced corn feed on a ton-for-ton basis during 1969-79, rice and corn are the only grains whose feed usage is influenced by policies. Actual, estimated, and simulated rice feed usage were compared in Table 7.10; the equivalent comparisons for corn feed are made in Table 7.12 and Figure 7.10. The differences between simulated and estimated values show the extent to which predicting the values of policy variables reduces the accuracy of the Japanese Grains Model, compared to the situation when policies are known. Thus the fairly close fit of the lines plotting simulated and estimated values in Figure 7.10 demonstrates that when policy variables become endogenous, there is not too much degradation of the model's ability to track corn feed.

Rice yields are modeled as a time trend. This chapter adds no further information about their value. Wheat yields and barley yields depend on lagged wheat and barley supply prices. Tables 7.13 and 7.14, along with Figures 7.11 and 7.12, compare actual, estimated, and simulated yields for these two crops.

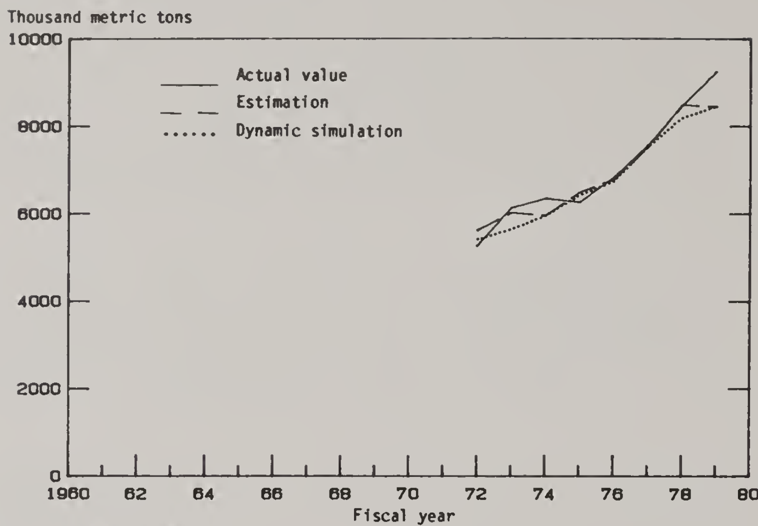
"Expected revenues" are defined as the previous year's supply price times the average of the previous 3 years' yields. Expected revenues averaged across several crops use the previous year's areas as crop weights. The estimated and simulated expected revenues shown in Tables 7.15 to 7.19 and in Figures 7.13 to 7.17 are calculated by a procedure which "pulls itself up by its own bootstraps" (as explained earlier on pages 121 and 127). In this procedure, actual values are used for all variables lagged from years before the 1969 beginning of the simulation period. 18/ Simulated expected revenues are calculated using simulated prices, simulated yields, and simulated areas lagged from 1969 and subsequent years. Estimated expected revenues are calculated using actual prices, estimated yields, and estimated areas lagged from 1969 and subsequent years.

Estimated and simulated expected revenues in turn are substituted into the equations that determine estimated and simulated areas (reported in Tables 7.20 to 7.24 and the accompanying graphs). For rice, wheat, and barley, quantities supplied are calculated as yield times area (Tables 7.25 to 7.27). Seed usage of these grains is calculated as a constant fraction of supply (see Table 7.28--because the residuals represent such small tonnages, only summary residual statistics are reported). Production net of seed follows from the obvious identity (Tables 7.29 to 7.31 and Figures 7.23 to 7.25). This chapter has nothing new to report on corn production net of seed or on other grain production net of seed, because both are estimated as time trends.

Finally, the food balance identities introduced in Chapter Six are applied to obtain actual, estimated, and simulated additions to stocks of rice (Table 7.32 and Figure 7.26), as well as actual, estimated, and simulated net imports of wheat, corn, and other coarse grains (Tables 7.33 to 7.35 and Figures 7.27 to 7.29).

--Text continues to page 259.

Figure 7.10
Actual, Estimated, and Simulated
Corn Used as Feed in Japan



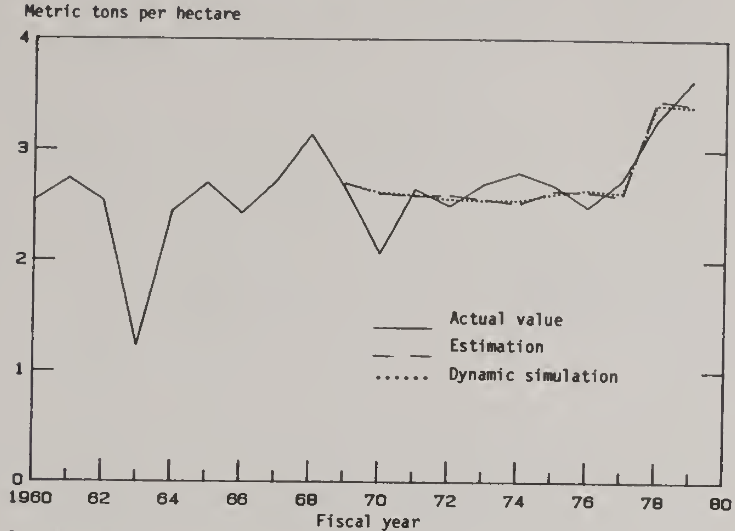
Source: Table 7.12

Table 7.12--Actual, estimated, and simulated corn used as feed

Fiscal year	Actual value	Estimation: Estimated value	Estimation: Residual	Estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1972	5,276	5,627	-351	-6.7	5,411	-135	-2.6
1973	6,142	6,024	118	1.9	5,651	491	8.0
1974	6,349	5,961	388	6.1	5,956	393	6.2
1975	6,263	6,495	-232	-3.7	6,427	-164	-2.6
1976	6,841	6,789	52	0.8	6,739	102	1.5
1977	7,578	7,536	42	0.6	7,533	45	0.6
1978	8,486	8,497	-11	-0.1	8,205	281	3.3
1979	9,256	8,454	802	8.7	8,456	800	8.6
		Mean absolute value:	250	3.6		301	4.2
		Root mean square:	352	4.7		383	5.0

Sources: Table 2.4, model estimates, and model simulations.

Figure 7.11
Actual, Estimated, and Simulated Wheat Yield in Japan



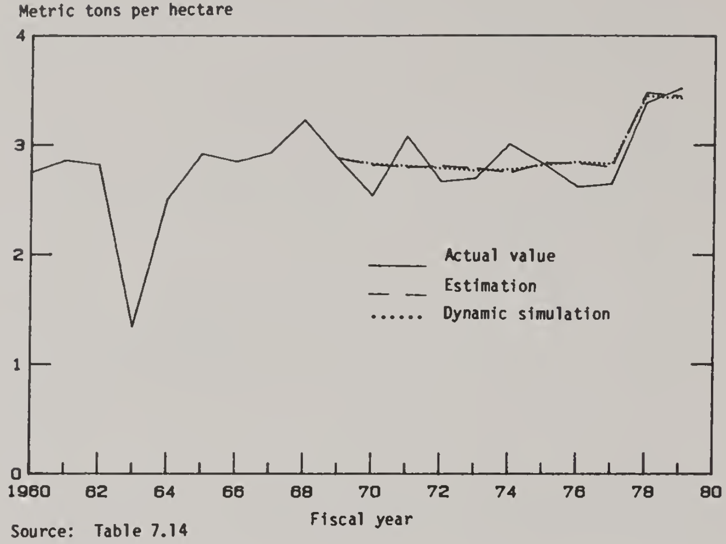
Source: Table 7.13

Table 7.13--Actual, estimated, and simulated wheat yield

Fiscal year	Actual value	Estimation: Estimated value	Estimation: Residual	Estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	-- Metric tons per hectare --			Percent	Metric tons / hectare		Percent
1960	2.54	--	--	--	--	--	--
1961	2.74	--	--	--	--	--	--
1962	2.54	--	--	--	--	--	--
1963	1.23	--	--	--	--	--	--
1964	2.45	--	--	--	--	--	--
1965	2.70	--	--	--	--	--	--
1966	2.43	--	--	--	--	--	--
1967	2.72	--	--	--	--	--	--
1968	3.14	--	--	--	--	--	--
1969	2.65	2.70	-0.05	-1.9	2.70	-0.05	-1.9
1970	2.07	2.61	-0.54	-26.1	2.62	-0.55	-26.6
1971	2.65	2.59	0.06	2.3	2.60	0.05	1.9
1972	2.50	2.60	-0.10	-4.0	2.56	-0.06	-2.4
1973	2.70	2.56	0.14	5.2	2.55	0.15	5.6
1974	2.80	2.52	0.28	10.0	2.55	0.25	8.9
1975	2.69	2.64	0.05	1.9	2.61	0.08	3.0
1976	2.49	2.63	-0.14	-5.6	2.65	-0.16	-6.4
1977	2.74	2.59	0.15	5.5	2.62	0.12	4.4
1978	3.28	3.46	-0.18	-5.5	3.42	-0.14	-4.3
1979	3.63	3.42	0.21	5.8	3.40	0.23	6.3
	Mean absolute value:		0.17	6.7		0.17	6.5
	Root mean square:		0.22	9.3		0.22	9.3

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.12
Actual, Estimated, and Simulated Barley Yield in Japan



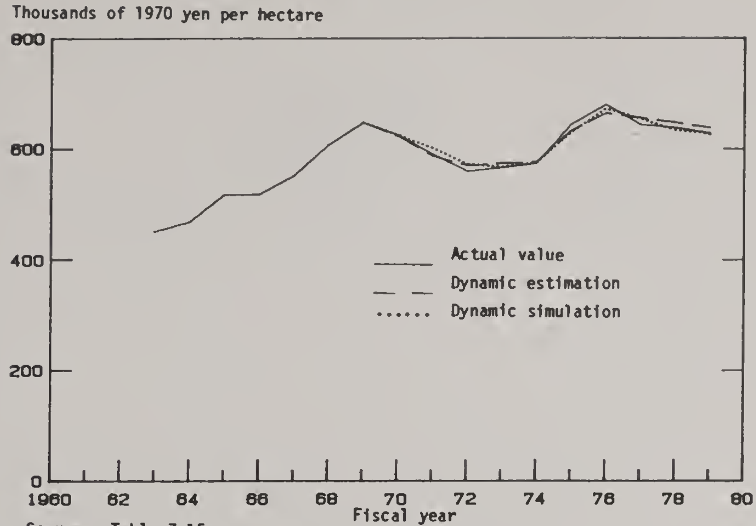
Source: Table 7.14

Table 7.14--Actual, estimated, and simulated barley yield

Fiscal year	Actual value	Estimation: Estimated value	Estimation: Residual	Estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	-- Metric tons per hectare --			Percent	Metric tons / hectare		Percent
1960	2.75	--	--	--	--	--	--
1961	2.86	--	--	--	--	--	--
1962	2.82	--	--	--	--	--	--
1963	1.34	--	--	--	--	--	--
1964	2.51	--	--	--	--	--	--
1965	2.92	--	--	--	--	--	--
1966	2.85	--	--	--	--	--	--
1967	2.93	--	--	--	--	--	--
1968	3.23	--	--	--	--	--	--
1969	2.87	2.88	-0.01	-0.3	2.88	-0.01	-0.3
1970	2.54	2.82	-0.28	-11.0	2.83	-0.29	-11.4
1971	3.08	2.80	0.28	9.1	2.81	0.27	8.8
1972	2.67	2.81	-0.14	-5.2	2.79	-0.12	-4.5
1973	2.70	2.79	-0.09	-3.3	2.77	-0.07	-2.6
1974	3.01	2.75	0.26	8.6	2.78	0.23	7.6
1975	2.83	2.84	-0.01	-0.4	2.82	0.01	0.4
1976	2.62	2.84	-0.22	-8.4	2.85	-0.23	-8.8
1977	2.65	2.80	-0.15	-5.7	2.83	-0.18	-6.8
1978	3.39	3.48	-0.09	-2.7	3.45	-0.06	-1.8
1979	3.52	3.45	0.07	2.0	3.43	0.09	2.6
	Mean absolute value:		0.15	5.2		0.14	5.0
	Root mean square:		0.17	6.3		0.17	6.2

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.13
Actual, Estimated, and Simulated Expected Revenue from Rice in Japan



Source: Table 7.15

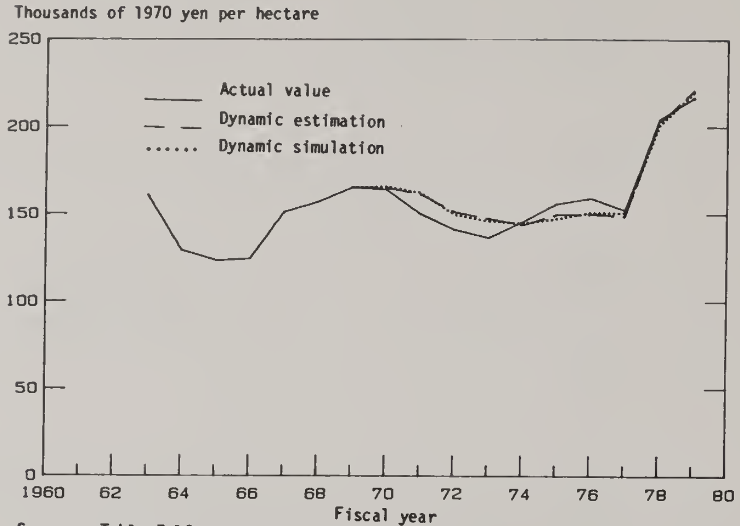
Table 7.15--Actual, estimated, and simulated expected revenue from rice

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1963	451.611	--	--	--	--	--	--
1964	468.536	--	--	--	--	--	--
1965	517.625	--	--	--	--	--	--
1966	517.936	--	--	--	--	--	--
1967	551.306	--	--	--	--	--	--
1968	607.260	--	--	--	--	--	--
1969	647.487	647.487	0.000	0.0	647.487	0.000	0.0
1970	624.758	622.853	1.905	0.3	624.973	-0.216	-0.0
1971	590.259	586.635	3.624	0.6	601.323	-11.064	-1.9
1972	559.858	570.029	-10.171	-1.8	572.684	-12.826	-2.3
1973	566.646	574.565	-7.919	-1.4	567.267	-0.620	-0.1
1974	574.481	576.661	-2.179	-0.4	575.925	-1.443	-0.3
1975	644.907	633.568	11.339	1.8	630.594	14.313	2.2
1976	680.356	664.705	15.652	2.3	673.190	7.166	1.1
1977	643.651	656.039	-12.387	-1.9	654.574	-10.922	-1.7
1978	638.333	647.618	-9.285	-1.5	633.774	4.559	0.7
1979	628.496	637.971	-9.475	-1.5	627.685	0.811	0.1
	Mean absolute value:		7.631	1.2		5.813	0.9
	Root mean square:		8.998	1.4		7.899	1.3

Note: Expected revenue is defined as the past year's supply price times the average of the past 3 years' yields.

Sources: Calculated from values for prices and yields reported in Tables 5.2 and 7.4.

Figure 7.14
Actual, Estimated, and Simulated
Expected Revenue from Wheat in Japan



Source: Table 7.16

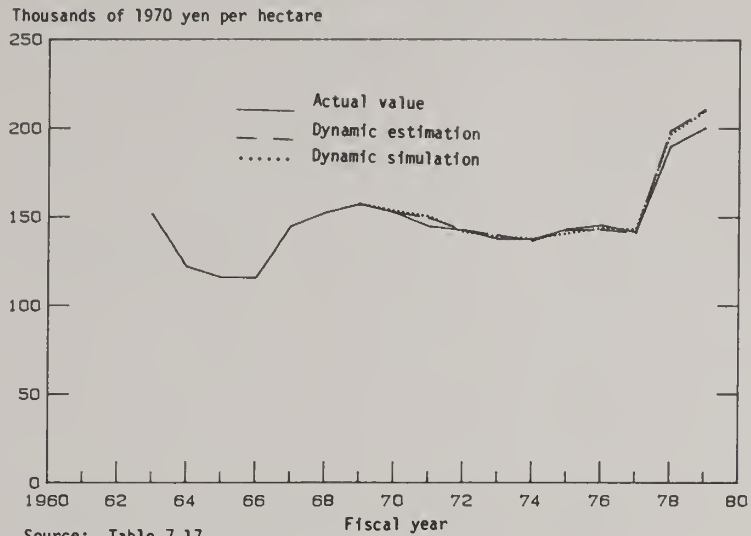
Table 7.16--Actual, estimated, and simulated expected revenue from wheat

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1963	160.315	--	--	--	--	--	--
1964	128.848	--	--	--	--	--	--
1965	123.096	--	--	--	--	--	--
1966	124.207	--	--	--	--	--	--
1967	150.868	--	--	--	--	--	--
1968	156.716	--	--	--	--	--	--
1969	164.864	164.864	0.000	0.0	164.864	0.000	0.0
1970	163.687	164.649	-0.962	-0.6	165.428	-1.741	-1.1
1971	149.812	161.057	-11.245	-7.5	162.008	-12.196	-8.1
1972	140.879	151.010	-10.131	-7.2	149.540	-8.661	-6.1
1973	136.284	147.232	-10.948	-8.0	145.838	-9.554	-7.0
1974	145.504	143.650	1.854	1.3	144.629	0.875	0.6
1975	155.842	149.609	6.234	4.0	147.281	8.561	5.5
1976	159.035	149.908	9.127	5.7	150.730	8.304	5.2
1977	152.131	148.509	3.622	2.4	150.686	1.444	0.9
1978	204.367	202.819	1.548	0.8	200.780	3.587	1.8
1979	216.587	220.914	-4.327	-2.0	219.783	-3.196	-1.5
	Mean absolute value:		5.454	3.6		5.284	3.4
	Root mean square:		6.807	4.6		6.649	4.5

Note: Expected revenue is defined as the past year's supply price times the average of the past 3 years' yields.

Sources: Calculated from values for prices and yields reported in Tables 5.3, 7.6, and 7.13.

Figure 7.15
Actual, Estimated, and Simulated
Expected Revenue from Barley in Japan



Source: Table 7.17

Table 7.17--Actual, estimated, and simulated expected revenue from barley

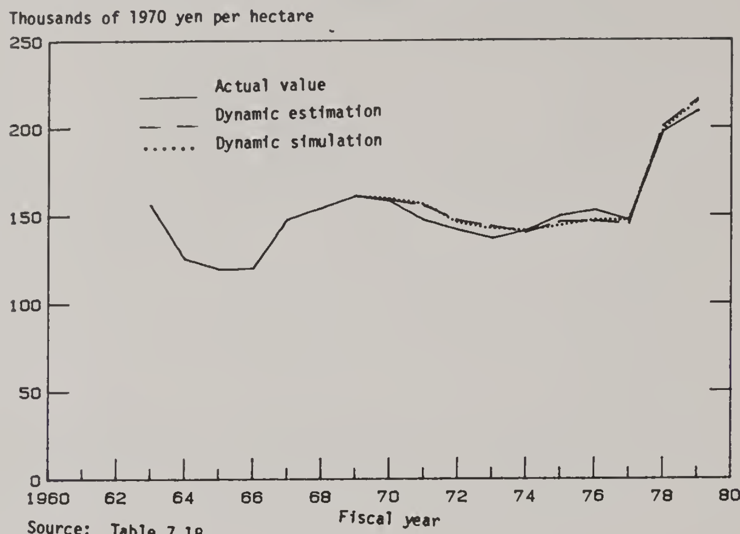
Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1963	151.471	--	--	--	--	--	--
1964	121.718	--	--	--	--	--	--
1965	115.708	--	--	--	--	--	--
1966	115.536	--	--	--	--	--	--
1967	144.460	--	--	--	--	--	--
1968	152.151	--	--	--	--	--	--
1969	157.035	157.035	0.000	0.0	157.035	0.000	0.0
1970	152.253	152.422	-0.169	-0.1	153.250	-0.996	-0.7
1971	144.374	149.220	-4.846	-3.4	150.175	-5.801	-4.0
1972	142.214	142.382	-0.168	-0.1	141.113	1.101	0.8
1973	137.162	139.478	-2.316	-1.7	138.617	-1.455	-1.1
1974	137.269	136.456	0.812	0.6	137.728	-0.459	-0.3
1975	143.088	142.576	0.512	0.4	140.663	2.425	1.7
1976	145.360	142.636	2.723	1.9	143.538	1.822	1.3
1977	141.327	140.826	0.501	0.4	143.013	-1.686	-1.2
1978	189.867	198.774	-8.907	-4.7	196.888	-7.022	-3.7
1979	200.206	210.841	-10.635	-5.3	209.919	-9.713	-4.9
	Mean absolute value:		2.872	1.7		2.953	1.8
	Root mean square:		4.572	2.5		4.198	2.4

Note: Expected revenue is defined as the past year's supply price times the average of the past 3 years' yields.

Sources: Calculated from values for prices and yields reported in Tables 5.4, 7.7, and 7.14.

Figure 7.16

Actual, Estimated, and Simulated
Expected Revenue from Wheat and Barley in Japan



Source: Table 7.18

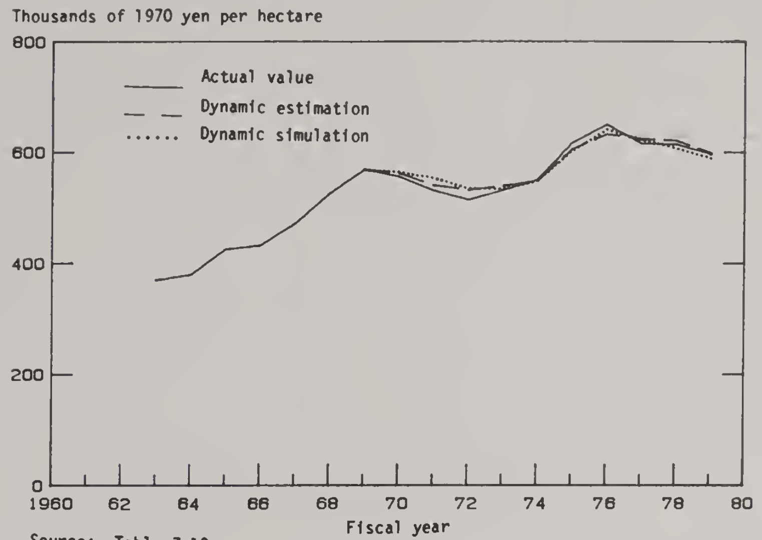
Table 7.18--Actual, estimated, and simulated expected revenue from wheat and barley

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1963	155.995	--	--	--	--	--	--
1964	125.339	--	--	--	--	--	--
1965	119.511	--	--	--	--	--	--
1966	120.132	--	--	--	--	--	--
1967	147.795	--	--	--	--	--	--
1968	154.481	--	--	--	--	--	--
1969	160.989	160.989	0.000	0.0	160.989	0.000	0.0
1970	158.005	158.702	-0.698	-0.4	159.505	-1.500	-0.9
1971	147.113	155.486	-8.373	-5.7	156.435	-9.321	-6.3
1972	141.541	146.945	-5.404	-3.8	145.567	-4.027	-2.8
1973	136.737	143.503	-6.766	-4.9	142.365	-5.628	-4.1
1974	141.251	140.173	1.078	0.8	141.280	-0.030	-0.0
1975	149.676	146.200	3.476	2.3	144.062	5.614	3.8
1976	152.666	146.368	6.299	4.1	147.220	5.446	3.6
1977	147.010	144.777	2.233	1.5	146.956	0.053	0.0
1978	197.480	200.863	-3.383	-1.7	198.895	-1.415	-0.7
1979	209.022	215.856	-6.834	-3.3	214.827	-5.804	-2.8
	Mean absolute value:		4.049	2.6		3.531	2.3
	Root mean square:		4.877	3.2		4.611	3.0

Note: Expected revenue is defined as the past year's supply price times the average of the past 3 years' yields.

Sources: Calculated as a weighted average of expected revenues reported in Tables 7.16 and 7.17, using as weights the previous year's areas as reported in Tables 7.22 and 7.23.

Figure 7.17
Actual, Estimated, and Simulated
Expected Revenue from Grains in Japan



Source: Table 7.19

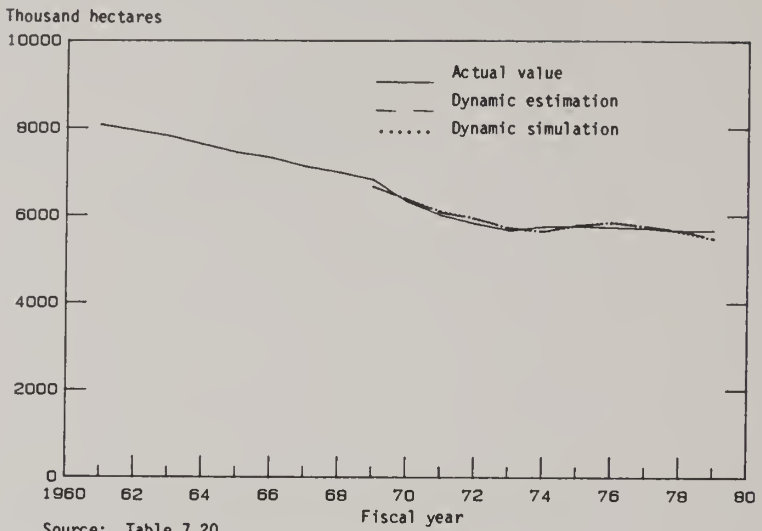
Table 7.19--Actual, estimated, and simulated expected revenue from grains

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousands of 1970 yen / hectare			Percent	Thous. 1970 yen / ha.		Percent
1963	369.893	--	--	--	--	--	--
1964	379.283	--	--	--	--	--	--
1965	425.104	--	--	--	--	--	--
1966	431.919	--	--	--	--	--	--
1967	470.961	--	--	--	--	--	--
1968	525.505	--	--	--	--	--	--
1969	568.236	568.236	0.000	0.0	568.236	0.000	0.0
1970	555.587	562.273	-6.685	-1.2	564.221	-8.634	-1.6
1971	530.569	540.143	-9.573	-1.8	553.133	-22.564	-4.3
1972	514.260	532.111	-17.851	-3.5	534.814	-20.554	-4.0
1973	531.520	539.903	-8.383	-1.6	533.741	-2.221	-0.4
1974	550.298	548.966	1.332	0.2	548.427	1.871	0.3
1975	617.384	605.861	11.523	1.9	602.557	14.827	2.4
1976	650.171	632.561	17.610	2.7	641.204	8.967	1.4
1977	615.117	624.221	-9.104	-1.5	623.029	-7.912	-1.3
1978	613.610	621.091	-7.482	-1.2	607.266	6.344	1.0
1979	596.823	598.640	-1.816	-0.3	589.111	7.712	1.3
	Mean absolute value:		8.305	1.4		9.237	1.6
	Root mean square:		10.055	1.8		11.588	2.1

Note: Expected revenue is defined as the past year's supply price times the average of the past 3 years' yields.

Sources: Calculated as a weighted average of expected revenues reported in Tables 7.15, 7.16, and 7.17, using as weights the previous year's areas as reported in Tables 7.21, 7.22, and 7.23.

Figure 7.18
Actual, Estimated, and Simulated
Gross Area Planted to All Crops in Japan



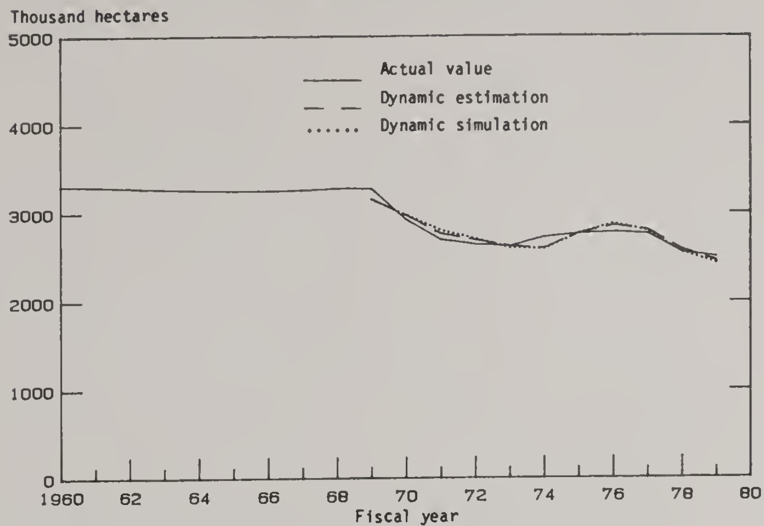
Source: Table 7.20

Table 7.20--Actual, estimated, and simulated gross area planted to all crops

Fiscal year	Actual value	Dynamic estimation			Dynamic simulation		
		Estimated value	Residual	Residual / actual	Simulated value	Residual	Residual / actual
	----- Thousand hectares	-----		Percent	Thousand hectares		Percent
1961	8,071	--	--	--	--	--	--
1962	7,999	--	--	--	--	--	--
1963	7,813	--	--	--	--	--	--
1964	7,619	--	--	--	--	--	--
1965	7,430	--	--	--	--	--	--
1966	7,312	--	--	--	--	--	--
1967	7,112	--	--	--	--	--	--
1968	6,979	--	--	--	--	--	--
1969	6,809	6,653	156	2.3	6,653	156	2.3
1970	6,311	6,370	-59	-0.9	6,374	-63	-1.0
1971	6,001	6,068	-67	-1.1	6,094	-93	-1.5
1972	5,812	5,932	-120	-2.1	5,937	-125	-2.2
1973	5,663	5,726	-63	-1.1	5,714	-51	-0.9
1974	5,752	5,642	110	1.9	5,641	111	1.9
1975	5,755	5,792	-37	-0.6	5,786	-31	-0.5
1976	5,730	5,842	-112	-2.0	5,857	-127	-2.2
1977	5,707	5,763	-56	-1.0	5,761	-54	-0.9
1978	5,656	5,663	-7	-0.1	5,640	16	0.3
1979	5,662	5,494	168	3.0	5,478	184	3.2
		Mean absolute value:	87	1.5		92	1.6
		Root mean square:	99	1.7		105	1.8

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.19
Actual, Estimated, and Simulated Rice Area in Japan



Source: Table 7.21

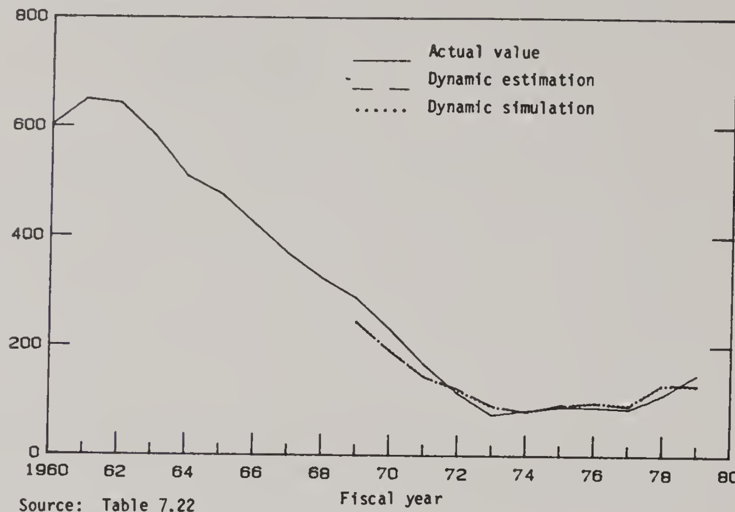
Table 7.21--Actual, estimated, and simulated rice area

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	----- Thousand hectares		-----	Percent	Thousand hectares		Percent
1960	3,308	--	--	--	--	--	--
1961	3,301	--	--	--	--	--	--
1962	3,285	--	--	--	--	--	--
1963	3,272	--	--	--	--	--	--
1964	3,260	--	--	--	--	--	--
1965	3,255	--	--	--	--	--	--
1966	3,254	--	--	--	--	--	--
1967	3,263	--	--	--	--	--	--
1968	3,280	--	--	--	--	--	--
1969	3,274	3,157	117	3.6	3,157	117	3.6
1970	2,923	2,976	-53	-1.8	2,980	-57	-2.0
1971	2,695	2,764	-69	-2.6	2,806	-111	-4.1
1972	2,640	2,692	-52	-2.0	2,706	-66	-2.5
1973	2,620	2,620	0	0.0	2,603	17	0.6
1974	2,724	2,598	126	4.6	2,592	132	4.8
1975	2,764	2,768	-4	-0.1	2,766	-2	-0.1
1976	2,779	2,854	-75	-2.7	2,875	-96	-3.5
1977	2,757	2,804	-47	-1.7	2,793	-36	-1.3
1978	2,548	2,582	-34	-1.3	2,549	-1	-0.0
1979	2,497	2,453	44	1.8	2,429	68	2.7
		Mean absolute value:	56	2.0		64	2.3
		Root mean square:	68	2.4		78	2.8

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.20

Actual, Estimated, and Simulated Wheat Area in Japan



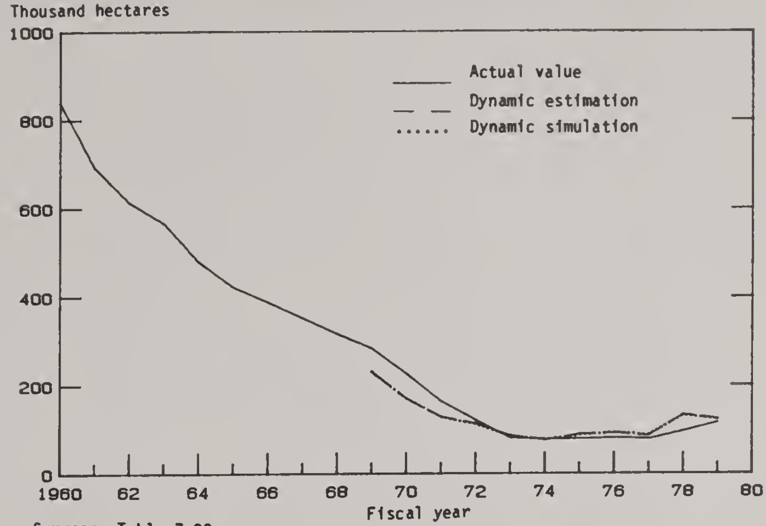
Source: Table 7.22

Table 7.22--Actual, estimated, and simulated wheat area

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	----- Thousand hectares	-----		Percent	Thousand hectares		Percent
1960	602.0	--	--	--	--	--	--
1961	649.0	--	--	--	--	--	--
1962	642.0	--	--	--	--	--	--
1963	584.0	--	--	--	--	--	--
1964	508.0	--	--	--	--	--	--
1965	476.0	--	--	--	--	--	--
1966	421.0	--	--	--	--	--	--
1967	367.0	--	--	--	--	--	--
1968	322.4	--	--	--	--	--	--
1969	286.5	243.4	43.1	15.0	243.4	43.1	15.0
1970	229.2	190.4	38.8	16.9	191.5	37.7	16.4
1971	166.3	143.9	22.4	13.5	144.3	22.0	13.2
1972	113.7	122.2	-8.5	-7.5	120.3	-6.6	-5.8
1973	74.9	91.7	-16.8	-22.4	90.5	-15.6	-20.8
1974	82.8	80.7	2.1	2.5	81.4	1.4	1.7
1975	89.6	93.9	-4.3	-4.8	91.7	-2.1	-2.3
1976	89.1	97.4	-8.3	-9.3	97.9	-8.8	-9.9
1977	86.0	91.4	-5.4	-6.3	93.5	-7.5	-8.7
1978	112.0	132.1	-20.1	-17.9	130.7	-18.7	-16.7
1979	149.0	129.8	19.2	12.9	129.3	19.7	13.2
	Mean absolute value:		17.2	11.7		16.7	11.3
	Root mean square:		21.6	13.1		21.2	12.7

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.21
Actual, Estimated, and Simulated Barley Area in Japan



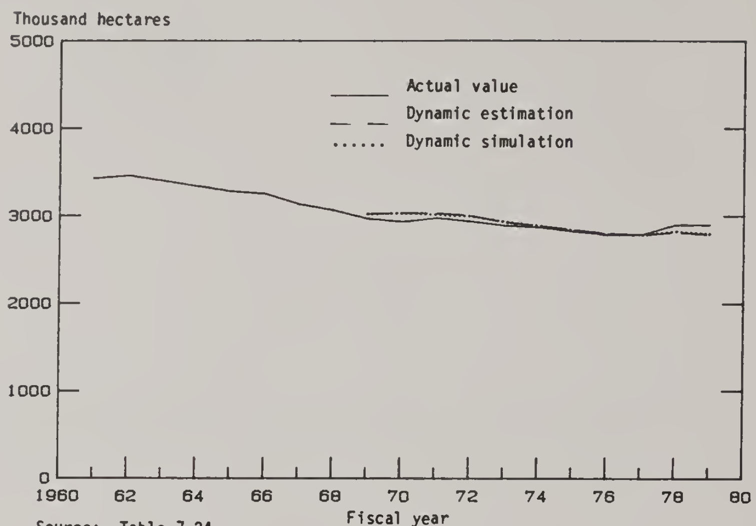
Source: Table 7.23

Table 7.23--Actual, estimated, and simulated barley area

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	----- Thousand hectares		-----	Percent	Thousand hectares		Percent
1960	838.0	--	--	--	--	--	--
1961	692.0	--	--	--	--	--	--
1962	613.0	--	--	--	--	--	--
1963	566.0	--	--	--	--	--	--
1964	479.0	--	--	--	--	--	--
1965	422.0	--	--	--	--	--	--
1966	388.0	--	--	--	--	--	--
1967	352.0	--	--	--	--	--	--
1968	315.9	--	--	--	--	--	--
1969	283.1	230.5	52.6	18.6	230.5	52.6	18.6
1970	225.8	169.3	56.5	25.0	170.5	55.3	24.5
1971	163.4	128.2	35.2	21.5	128.7	34.7	21.2
1972	121.2	113.2	8.0	6.6	111.5	9.7	8.0
1973	80.0	85.8	-5.8	-7.3	85.3	-5.3	-6.6
1974	77.5	75.9	1.6	2.1	77.1	0.4	0.5
1975	78.1	89.1	-11.0	-14.1	87.4	-9.3	-11.9
1976	80.3	92.0	-11.7	-14.6	92.6	-12.3	-15.3
1977	77.8	85.6	-7.8	-10.0	87.8	-10.0	-12.9
1978	96.1	133.2	-37.1	-38.6	132.0	-35.9	-37.4
1979	115.6	123.5	-7.9	-6.8	123.1	-7.5	-6.5
		Mean absolute value:	21.4	15.0		21.2	14.9
		Root mean square:	28.7	18.1		28.3	17.8

Sources: Table 2.7, model estimates, and model simulations.

Figure 7.22
Actual, Estimated, and Simulated
Other Nonrice Area in Japan



Source: Table 7.24

Table 7.24--Actual, estimated, and simulated other nonrice area

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	Thousand hectares	Thousand hectares	Thousand hectares	Percent	Thousand hectares	Thousand hectares	Percent
1960	--	--	--	--	--	--	--
1961	3,429	--	--	--	--	--	--
1962	3,459	--	--	--	--	--	--
1963	3,391	--	--	--	--	--	--
1964	3,372	--	--	--	--	--	--
1965	3,277	--	--	--	--	--	--
1966	3,249	--	--	--	--	--	--
1967	3,130	--	--	--	--	--	--
1968	3,061	--	--	--	--	--	--
1969	2,965	3,022	-57	-1.9	3,022	-57	-1.9
1970	2,933	3,034	-101	-3.4	3,032	-99	-3.4
1971	2,976	3,032	-56	-1.9	3,015	-39	-1.3
1972	2,937	3,005	-68	-2.3	2,999	-62	-2.1
1973	2,888	2,929	-41	-1.4	2,935	-47	-1.6
1974	2,868	2,887	-19	-0.7	2,891	-23	-0.8
1975	2,823	2,841	-18	-0.6	2,841	-18	-0.6
1976	2,782	2,799	-17	-0.6	2,792	-10	-0.4
1977	2,786	2,782	4	0.1	2,787	-1	-0.0
1978	2,900	2,816	84	2.9	2,828	72	2.5
1979	2,900	2,788	112	3.9	2,797	103	3.6
Mean absolute value:			52	1.8		48	1.7
Root mean square:			63	2.2		58	2.0

Note: The other nonrice area is defined as the gross total area planted less the areas planted to rice, wheat, and barley.

Sources: Derived from Table 2.7, model estimates, and model simulations.

Table 7.25--Actual, estimated, and simulated rice supply

Fiscal year	Actual value	Dynamic estimation			Dynamic simulation		
		Estimated value	Residual	Residual / actual	Simulated value	Residual	Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	12,858	--	--	--	--	--	--
1961	12,419	--	--	--	--	--	--
1962	13,009	--	--	--	--	--	--
1963	12,812	--	--	--	--	--	--
1964	12,584	--	--	--	--	--	--
1965	12,409	--	--	--	--	--	--
1966	12,745	--	--	--	--	--	--
1967	14,453	--	--	--	--	--	--
1968	14,449	--	--	--	--	--	--
1969	14,003	13,386	617	4.4	13,386	617	4.4
1970	12,689	12,797	-108	-0.9	12,814	-125	-1.0
1971	10,887	12,023	-1,136	-10.4	12,206	-1,319	-12.1
1972	11,889	11,872	17	0.1	11,933	-44	-0.4
1973	12,149	11,711	438	3.6	11,635	514	4.2
1974	12,292	11,769	523	4.3	11,742	550	4.5
1975	13,165	12,705	460	3.5	12,696	469	3.6
1976	11,772	13,271	-1,499	-12.7	13,369	-1,597	-13.6
1977	13,095	13,207	-112	-0.9	13,155	-60	-0.5
1978	12,589	12,342	247	2.0	12,184	405	3.2
1979	11,958	11,873	85	0.7	11,756	202	1.7
Residual from all causes							
		Mean absolute value:	477	4.0		537	4.5
		Root mean square:	653	5.6		719	6.1
Residual from error in yield							
		Mean absolute value:	373	3.1		373	3.1
		Root mean square:	500	4.3		502	4.3
Residual from error in area							
		Mean absolute value:	251	2.0		250	2.0
		Root mean square:	301	2.4		300	2.4

Notes: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

See page 142 for an explanation of how each residual was split into a component due to the error in estimated or simulated yield plus a component due to the error in estimated or simulated area.

Sources: Calculated as yields from Table 5.2 multiplied by areas from Table 7.21.

Table 7.26--Actual, estimated, and simulated wheat supply

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	1,531	--	--	--	--	--	--
1961	1,781	--	--	--	--	--	--
1962	1,631	--	--	--	--	--	--
1963	716	--	--	--	--	--	--
1964	1,244	--	--	--	--	--	--
1965	1,287	--	--	--	--	--	--
1966	1,024	--	--	--	--	--	--
1967	997	--	--	--	--	--	--
1968	1,012	--	--	--	--	--	--
1969	758	657	101	13.3	657	101	13.3
1970	474	497	-23	-4.9	502	-28	-5.9
1971	440	373	67	15.2	375	65	14.8
1972	284	318	-34	-12.0	308	-24	-8.5
1973	202	235	-33	-16.3	231	-29	-14.4
1974	232	203	29	12.5	208	24	10.3
1975	241	248	-7	-2.9	239	2	0.8
1976	222	256	-34	-15.3	259	-37	-16.7
1977	236	237	-1	-0.4	245	-9	-3.8
1978	367	457	-90	-24.5	447	-80	-21.8
1979	541	444	97	17.9	440	101	18.7
Residual from all causes							
		Mean absolute value:	47	12.3		45	11.7
		Root mean square:	58	14.0		57	13.3
Residual from error in yield							
		Mean absolute value:	24	6.6		23	6.4
		Root mean square:	37	8.8		38	8.8
Residual from error in area							
		Mean absolute value:	47	11.9		48	12.3
		Root mean square:	58	13.4		59	13.7

Note: See page 142 for an explanation of how each residual was split into a component due to the error in estimated or simulated yield plus a component due to the error in estimated or simulated area.

Sources: Calculated as yields from Table 7.13 multiplied by areas from Table 7.22.

Table 7.27--Actual, estimated, and simulated barley supply

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	2,301	--	--	--	--	--	--
1961	1,976	--	--	--	--	--	--
1962	1,726	--	--	--	--	--	--
1963	759	--	--	--	--	--	--
1964	1,202	--	--	--	--	--	--
1965	1,234	--	--	--	--	--	--
1966	1,105	--	--	--	--	--	--
1967	1,032	--	--	--	--	--	--
1968	1,021	--	--	--	--	--	--
1969	812	664	148	18.2	664	148	18.2
1970	573	477	96	16.8	483	90	15.7
1971	503	359	144	28.6	362	141	28.0
1972	324	318	6	1.9	311	13	4.0
1973	216	239	-23	-10.6	236	-20	-9.3
1974	233	209	24	10.3	214	19	8.2
1975	221	253	-32	-14.5	246	-25	-11.3
1976	210	261	-51	-24.3	264	-54	-25.7
1977	206	240	-34	-16.5	248	-42	-20.4
1978	326	464	-138	-42.3	455	-129	-39.6
1979	407	426	-19	-4.7	422	-15	-3.7
Residual from all causes							
Mean absolute value:			65	17.2		63	16.7
Root mean square:			84	20.3		81	19.8
Residual from error in yield							
Mean absolute value:			17	5.1		17	4.9
Root mean square:			23	6.0		24	6.0
Residual from error in area							
Mean absolute value:			62	15.2		63	15.4
Root mean square:			83	18.3		84	18.6

Note: See page 142 for an explanation of how each residual was split into a component due to the error in estimated or simulated yield plus a component due to the error in estimated or simulated area.

Sources: Calculated as yields from Table 7.14 multiplied by areas from Table 7.23.

Table 7.28--Actual, estimated, and simulated seed usage of rice, wheat, and barley

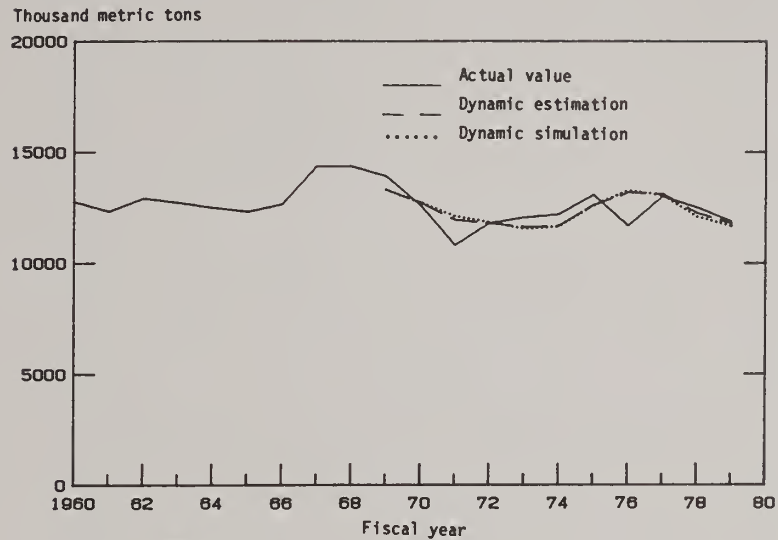
Fiscal year	Rice used as seed			Wheat used as seed			Barley used as seed		
	Actual value	Estimated value	Simulated value	Actual value	Estimated value	Simulated value	Actual value	Estimated value	Simulated value
				Thousand metric tons					
1960	104	--	--	40	--	--	42	--	--
1961	101	--	--	43	--	--	37	--	--
1962	98	--	--	38	--	--	35	--	--
1963	101	--	--	31	--	--	27	--	--
1964	101	--	--	27	--	--	23	--	--
1965	101	--	--	26	--	--	20	--	--
1966	103	--	--	22	--	--	19	--	--
1967	103	--	--	24	--	--	22	--	--
1968	104	--	--	22	--	--	18	--	--
1969	105	100	100	17	26	26	14	17	17
1970	99	96	96	11	20	20	10	12	12
1971	93	90	92	9	15	15	8	9	9
1972	94	89	89	6	13	12	5	8	8
1973	91	88	87	5	9	9	5	6	6
1974	93	88	88	8	8	8	5	5	5
1975	96	95	95	9	10	10	6	6	6
1976	98	100	100	8	10	10	5	7	7
1977	97	99	99	10	9	10	5	6	6
1978	92	93	91	14	18	18	8	12	11
1979	90	89	88	21	18	18	11	11	11
Mean absolute value									
Residual:		3	3		4	4		2	1
Percent residual:		2.9%	2.9%		44%	42%		22%	21%
Root mean square									
Residual:		3	3		5	5		2	2
Percent residual:		3.3%	3.4%		57%	54%		29%	28%

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Tables 2.1 to 2.3, dynamic model estimates, and dynamic model simulations.

Figure 7.23

Actual, Estimated, and Simulated Japanese Rice Production Net of Seed Used



Source: Table 7.29

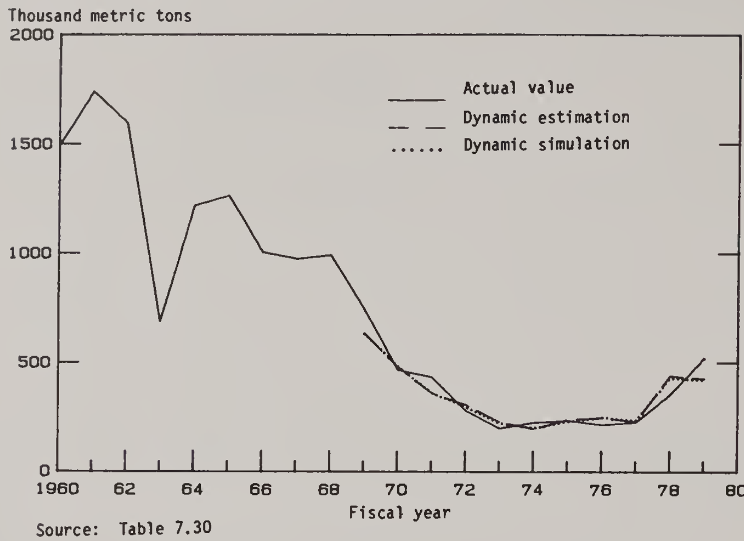
Table 7.29--Actual, estimated, and simulated rice production net of seed used

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	12,754	--	--	--	--	--	--
1961	12,318	--	--	--	--	--	--
1962	12,911	--	--	--	--	--	--
1963	12,711	--	--	--	--	--	--
1964	12,483	--	--	--	--	--	--
1965	12,308	--	--	--	--	--	--
1966	12,642	--	--	--	--	--	--
1967	14,350	--	--	--	--	--	--
1968	14,345	--	--	--	--	--	--
1969	13,898	13,286	612	4.4	13,286	612	4.4
1970	12,590	12,701	-111	-0.9	12,718	-128	-1.0
1971	10,794	11,933	-1,139	-10.6	12,114	-1,320	-12.2
1972	11,795	11,783	12	0.1	11,844	-49	-0.4
1973	12,058	11,623	435	3.6	11,548	510	4.2
1974	12,199	11,681	518	4.2	11,654	545	4.5
1975	13,069	12,610	459	3.5	12,601	468	3.6
1976	11,674	13,171	-1,497	-12.8	13,269	-1,595	-13.7
1977	12,998	13,108	-110	-0.8	13,056	-58	-0.4
1978	12,497	12,249	248	2.0	12,093	404	3.2
1979	11,868	11,784	84	0.7	11,668	200	1.7
	Mean absolute value:		475	4.0		535	4.5
	Root mean square:		652	5.6		717	6.2

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Calculated from Tables 7.25 and 7.28.

Figure 7.24
Actual, Estimated, and Simulated
Japanese Wheat Production Net of Seed Used



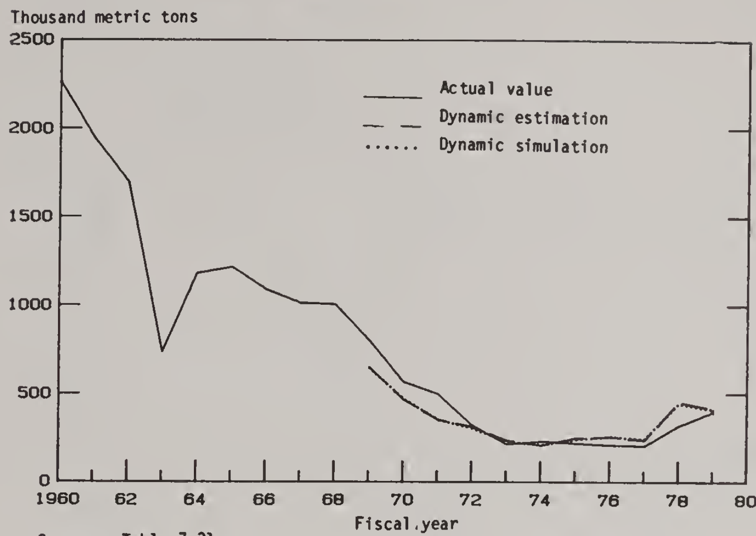
Source: Table 7.30

Table 7.30--Actual, estimated, and simulated wheat production net of seed used

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	1,491	--	--	--	--	--	--
1961	1,738	--	--	--	--	--	--
1962	1,593	--	--	--	--	--	--
1963	685	--	--	--	--	--	--
1964	1,217	--	--	--	--	--	--
1965	1,261	--	--	--	--	--	--
1966	1,002	--	--	--	--	--	--
1967	973	--	--	--	--	--	--
1968	990	--	--	--	--	--	--
1969	741	631	110	14.8	631	110	14.8
1970	463	477	-14	-3.0	482	-19	-4.1
1971	431	358	73	16.9	360	71	16.5
1972	278	305	-27	-9.7	296	-18	-6.5
1973	197	226	-29	-14.7	222	-25	-12.7
1974	224	195	29	12.9	200	24	10.7
1975	232	238	-6	-2.6	229	3	1.3
1976	214	246	-32	-15.0	249	-35	-16.4
1977	226	228	-2	-0.9	235	-9	-4.0
1978	353	439	-86	-24.4	429	-76	-21.5
1979	520	426	94	18.1	422	98	18.8
		Mean absolute value:	46	12.1		44	11.6
		Root mean square:	58	14.0		57	13.2

Sources: Calculated from Tables 7.26 and 7.28.

Figure 7.25
Actual, Estimated, and Simulated
Japanese Barley Production Net of Seed Used



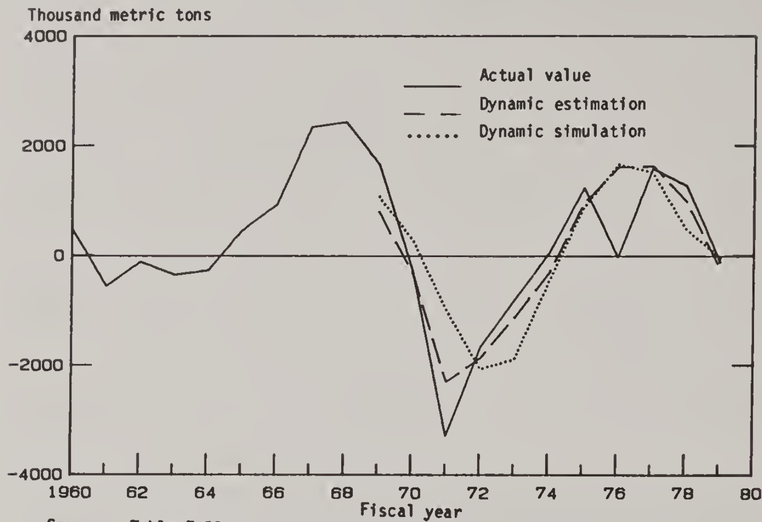
Source: Table 7.31

Table 7.31--Actual, estimated, and simulated barley production net of seed used

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	2,259	--	--	--	--	--	--
1961	1,939	--	--	--	--	--	--
1962	1,691	--	--	--	--	--	--
1963	732	--	--	--	--	--	--
1964	1,179	--	--	--	--	--	--
1965	1,214	--	--	--	--	--	--
1966	1,086	--	--	--	--	--	--
1967	1,010	--	--	--	--	--	--
1968	1,003	--	--	--	--	--	--
1969	798	647	151	18.9	647	151	18.9
1970	563	465	98	17.4	471	92	16.3
1971	495	350	145	29.3	353	142	28.7
1972	319	310	9	2.8	303	16	5.0
1973	211	233	-22	-10.4	230	-19	-9.0
1974	228	204	24	10.5	209	19	8.3
1975	215	247	-32	-14.9	240	-25	-11.6
1976	205	254	-49	-23.9	257	-52	-25.4
1977	201	234	-33	-16.4	242	-41	-20.4
1978	318	452	-134	-42.1	444	-126	-39.6
1979	396	415	-19	-4.8	411	-15	-3.8
	Mean absolute value:		65	17.4		63	17.0
	Root mean square:		84	20.5		82	20.0

Sources: Calculated from Tables 7.27 and 7.28.

Figure 7.26
Actual, Estimated, and Simulated
Additions to Stocks of Rice in Japan



Source: Table 7.32

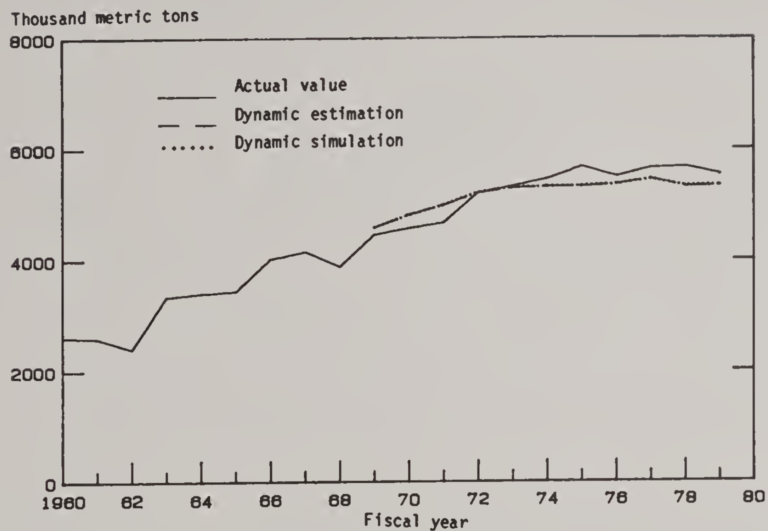
Table 7.32--Actual, estimated, and simulated additions to stocks of rice

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	---- Thousand metric tons ----			Percent	Thousand metric tons		Percent
1960	459	--	--	--	--	--	--
1961	-566	--	--	--	--	--	--
1962	-124	--	--	--	--	--	--
1963	-359	--	--	--	--	--	--
1964	-275	--	--	--	--	--	--
1965	468	--	--	--	--	--	--
1966	921	--	--	--	--	--	--
1967	2,334	--	--	--	--	--	--
1968	2,428	--	--	--	--	--	--
1969	1,646	787	859	52	1,072	574	35
1970	-281	-318	37	-13	283	-564	201
1971	-3,295	-2,301	-994	30	-992	-2,303	70
1972	-1,670	-1,868	198	-12	-2,070	400	-24
1973	-801	-1,117	316	-39	-1,894	1,093	-136
1974	51	-310	361	708	-475	526	1,031
1975	1,228	952	276	22	866	362	29
1976	-32	1,616	-1,648	5,150	1,666	-1,698	5,306
1977	1,583	1,638	-55	-3	1,515	68	4
1978	1,269	983	286	23	487	782	62
1979	-108	-238	130	-120	-45	-63	58
		Mean absolute value:	469	561		767	632
		Root mean square:	667	1,568		1,010	1,632

Note: Rice statistics are on a brown basis. One unit of brown rice equals from 0.905 to 0.912 units of milled rice--see note 2 on page 34 for details.

Sources: Table 2.1, model estimates, and model simulations.

Figure 7.27
Actual, Estimated, and Simulated
Net Imports of Wheat by Japan



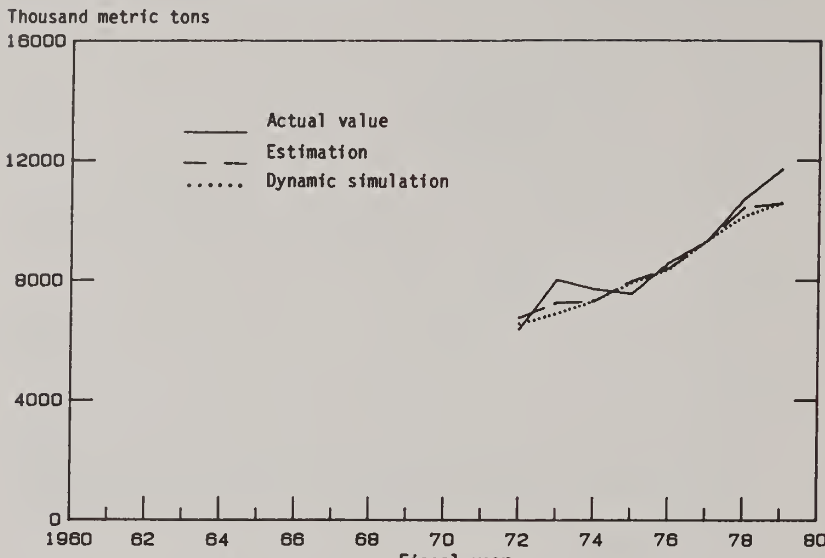
Source: Table 7.33

Table 7.33--Actual, estimated, and simulated net imports of wheat

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1960	2,613	--	--	--	--	--	--
1961	2,589	--	--	--	--	--	--
1962	2,397	--	--	--	--	--	--
1963	3,339	--	--	--	--	--	--
1964	3,403	--	--	--	--	--	--
1965	3,444	--	--	--	--	--	--
1966	4,024	--	--	--	--	--	--
1967	4,151	--	--	--	--	--	--
1968	3,882	--	--	--	--	--	--
1969	4,456	4,585	-129	-2.9	4,585	-129	-2.9
1970	4,574	4,817	-243	-5.3	4,812	-238	-5.2
1971	4,671	4,990	-319	-6.8	4,988	-317	-6.8
1972	5,212	5,211	1	0.0	5,220	-8	-0.2
1973	5,331	5,301	30	0.6	5,305	26	0.5
1974	5,459	5,324	135	2.5	5,319	140	2.6
1975	5,681	5,324	357	6.3	5,333	348	6.1
1976	5,501	5,365	136	2.5	5,362	139	2.5
1977	5,658	5,458	200	3.5	5,451	207	3.7
1978	5,677	5,319	358	6.3	5,329	348	6.1
1979	5,540	5,336	204	3.7	5,340	200	3.6
Mean absolute value:			192	3.7		191	3.6
Root mean square:			224	4.3		221	4.2

Sources: Table 2.2, model estimates, and model simulations.

Figure 7.28
Actual, Estimated, and Simulated
Net Imports of Corn by Japan



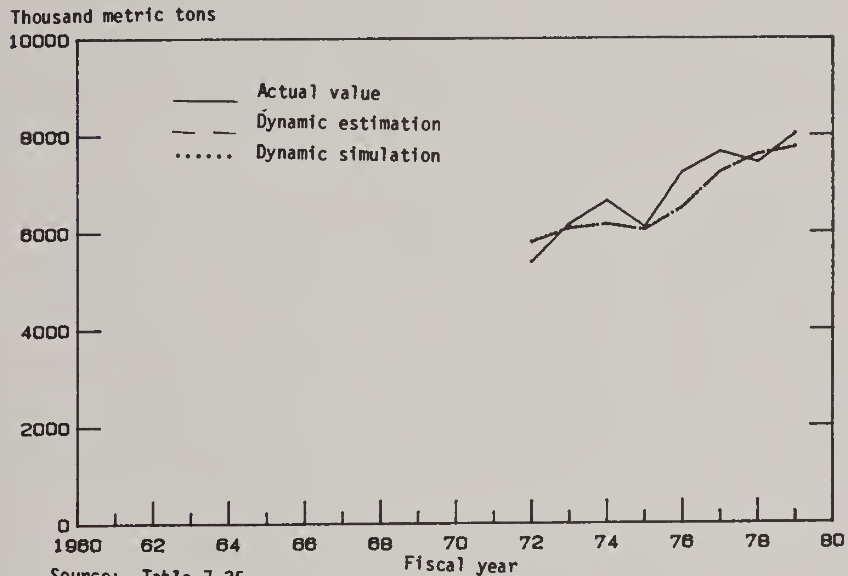
Source: Table 7.34

Table 7.34--Actual, estimated, and simulated net imports of corn

Fiscal year	Actual value	Estimation: Estimated value	Estimation: Residual	Estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1972	6,364	6,758	-394	-6.2	6,542	-178	-2.8
1973	8,021	7,270	751	9.4	6,897	1,124	14.0
1974	7,719	7,331	388	5.0	7,326	393	5.1
1975	7,568	7,996	-428	-5.7	7,928	-360	-4.8
1976	8,612	8,431	181	2.1	8,381	231	2.7
1977	9,313	9,327	-14	-0.2	9,324	-11	-0.1
1978	10,736	10,452	284	2.6	10,160	576	5.4
1979	11,707	10,584	1,123	9.6	10,586	1,121	9.6
	Mean absolute value:		445	5.1		499	5.5
	Root mean square:		551	6.0		635	6.9

Sources: Table 2.4, model estimates, and model simulations.

Figure 7.29
Actual, Estimated, and Simulated
Net Imports of Other Coarse Grains by Japan



Source: Table 7.35

Table 7.35--Actual, estimated, and simulated net imports of other coarse grains

Fiscal year	Actual value	Dynamic estimation: Estimated value	Dynamic estimation: Residual	Dynamic estimation: Residual / actual	Dynamic simulation: Simulated value	Dynamic simulation: Residual	Dynamic simulation: Residual / actual
	--- Thousand metric tons ---			Percent	Thousand metric tons		Percent
1972	5,389	5,803	-414	-7.7	5,810	-421	-7.8
1973	6,176	6,085	91	1.5	6,088	88	1.4
1974	6,655	6,173	482	7.2	6,168	487	7.3
1975	6,110	6,049	61	1.0	6,056	54	0.9
1976	7,245	6,514	731	10.1	6,511	734	10.1
1977	7,663	7,249	414	5.4	7,241	422	5.5
1978	7,440	7,609	-169	-2.3	7,617	-177	-2.4
1979	8,032	7,752	280	3.5	7,756	276	3.4
Mean absolute value:			330	4.8		332	4.9
Root mean square:			392	5.7		395	5.8

Note: Other coarse grains equal barley plus other grain.

Sources: Calculated from Tables 2.3 and 2.5, model estimates, and model simulations.

Table 7.36--Regression equations for the rice supply price

Regression statistics	Intercept	Ave. excess rice productn, previous 6 yrs JPQERIF6	ln(Rice trade price, previous year) JPLPTRI1	ln(Rice supply price/ trade price, prev.yr) JPLPSTR1	Comments
58.69% 0.847 .537	4.55 ± 0.09 (48) 0.01%		0.092 ± .024 (3.9) 0.36%		
50.64% 0.828 .537	5.01 ± 0.03 (179) 0.01%			-0.093 ± .028 (3.4) 0.85%	
46.51% 0.818 .402	4.98 ± 0.02 (239) 0.01%	-0.000088 ± .000028 (3.1) 1.2%			Weak $\overline{R}^2$.
91.04% 1.736 -.101	4.66 ± 0.05 (98) 0.01%	-0.000069 ± .000012 (5.8) 0.04%	0.076 ± .011 (6.8) 0.01%		
91.92% 1.897 -.210	5.05 ± 0.01 (399) 0.01%	-0.000076 ± .000011 (6.9) 0.01%		-0.082 ± .011 (7.2) 0.01%	EQUATION USED IN MODEL.

Regression statistics	Intercept	Time trend YEAR	Comments
-10.56% 0.844 .456	6.7 ± 8.4 (0.80) 44%	-0.0009 ± .0042 (0.21) 84%	Insignificant $\overline{R}^2$ and coefficient for time.

All regressions were run over the 11-year interval spanning Japanese fiscal years 1969-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

Independent variables:

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPLPTRI1 = Japan, logarithm of trade price for rice, 5 percent broken, f.o.b. Bangkok, previous calendar year (1970 yen per kilogram)

JPLPSTR1 = Japan, logarithm of ratio: (rice supply price) / (rice trade price), previous year

YEAR = Japanese fiscal year (values from 1969 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 7.36 lists alternative regression equations for the rice supply price. The table shows that combinations of the excess production variable and a trade price variable have far more explanatory power than either type of variable alone. There is little difference in the performance of the two measures of the rice trade price. In Equation [82] of the model, the lagged value of the dependent variable JPLPSRI appears as part of the explanatory variable JPLPSTR1. A researcher with qualms about this may substitute the regression equation:

$$\begin{array}{llll} \text{JPLPSRI} = & 4.660629 & - \; 0.0000691861 \text{ JPQERIF6} & + \; 0.076386 \text{ JPLPTRI1} \\ & \pm\, 0.047796 & \pm\, 0.0000119556 & \pm\, 0.011296 \\ & (97.51) & (5.787) & (6.762) \\ & 0.01\% & 0.04\% & 0.01\% \end{array}$$

Adjusted R^2 = 91.04 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 1.736
Autocorrelation of residuals = -0.101

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPLPTRI1 = Japan, logarithm of trade price for rice, 5 percent broken, f.o.b. Bangkok, previous calendar year (1970 yen per kilogram)

Because the adjusted R^2 statistic of this alternative equation (91.04 percent) is almost as high as the adjusted R^2 of the equation used in the model (91.92 percent), switching equations would have very little effect on the rest of the model.

Table 7.37 shows what happens when alternative lag structures for average past excess rice production are substituted into the regression equation used in the model. It demonstrates the superior explanatory power of the 6 year average (the variable JPQERIF6) for simulating the rice supply price.

Table 7.38 lists alternative regression equations for the wheat supply price. First, it shows that the FROM1977 dummy variable by itself explains 98.48 percent of the variance in the logarithm of the wheat supply price. Second, for regressions including FROM1977 and one other variable, the table shows that the rice supply price and both measures of the lagged wheat trade price appear about equal in terms of their explanatory power and significance levels. Third, the table shows that problems arise for regressions including FROM1977 and two other explanatory variables. In these regression equations, multicollinearity (nearly parallel movement in the values of several explanatory variables) causes statistical interference between the rice supply price and the lagged wheat trade price. In the regressions with two price variables, the magnitude of each price coefficient is only about one-half to two-thirds as large as the corresponding price coefficient in a regression

Table 7.37--The effect of alternative lag specifications on regression equations for the rice supply price

Period over which excess rice production averaged	Adjusted R^2 statistic	Coefficient for past excess rice production	$\pm$	Standard error	(t-statistic)	Significance level
1 to 4 years ago	66.90%	-0.000030	$\pm$	.000013	(2.3)	4.8%
1 to 5 years ago	85.15%	-0.000055	$\pm$	.000012	(4.7)	.16%
1 to 6 years ago	91.92%	-0.000076	$\pm$	.000011	(6.9)	.01%
1 to 7 years ago	77.19%	-0.000088	$\pm$	.000026	(3.4)	.95%
2 to 4 years ago	73.30%	-0.000029	$\pm$	.000010	(2.9)	1.9%
2 to 5 years ago	81.37%	-0.000040	$\pm$	.000010	(4.0)	.41%
2 to 6 years ago	78.51%	-0.000046	$\pm$	.000013	(3.6)	.74%
2 to 7 years ago	62.18%	-0.000041	$\pm$	.000021	(1.9)	8.9%

Notes: Regression equations include coefficients not listed in this table.

Each t-statistic is expressed in terms of its absolute value.

Source: Model estimates.

Table 7.38--Regression equations for the wheat supply price

Regression statistics	Intercept	Dummy variable set =1 since 1977, =0 before FROM1977	ln(Wheat trade price, previous year) JPLPTWH1	ln(Wheat supply price/ trade price, prev.yr) JPLPSTW1	ln(Rice supply price) JPLPSRI	Comments
98.48% 1.824 -.003	4.048 ± 0.006 (695) 0.01%	0.28 ± .01 (25) 0.01%				
99.52% 2.274 -.195	3.85 ± 0.04 (88) 0.01%	0.312 ± .009 (35) 0.01%	0.062 ± .014 (4.5) 0.20%			
99.38% 2.503 -.291	4.09 ± 0.01 (335) 0.01%	0.32 ± .01 (29) 0.01%		-0.049 ± .013 (3.7) 0.58%		
99.47% 2.389 -.234	2.5 ± 0.4 (6.6) 0.02%	0.293 ± .007 (43) 0.01%			0.32 ± .08 (4.2) 0.29%	EQUATION USED IN MODEL.
99.49% 2.216 -.147	3.3 ± 0.8 (4.2) 0.40%	0.31 ± .01 (24) 0.01%	0.038 ± .033 (1.2) 29%		0.14 ± 0.18 (0.77) 47%	Poor coefficients for wheat and rice prices.
99.49% 2.317 -.180	3.0 ± 0.6 (4.8) 0.19%	0.30 ± .01 (25) 0.01%		-0.023 ± .020 (1.1) 30%	0.21 ± .13 (1.6) 14%	Poor coefficient for wheat price, weak coefficient for rice price.

All regressions were run over the 11-year interval spanning Japanese fiscal years 1969-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLPSWH = Japan, logarithm of wheat supply price (1970 yen per kilogram)

Independent variables: FROM1977 = Dummy variable (equals 0 through 1976; equals 1 since 1977)

JPLPTWH1 = Japan, logarithm of trade price for wheat, No. 2 hard red winter ordinary protein, f.o.b. U.S. Gulf ports, previous calendar year (1970 yen per kilogram)

JPLPSTW1 = Japan, logarithm of ratio: (wheat supply price) / (wheat trade price), previous year

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

with just one price variable. The implication is that the eleven observations available allow reliable estimation of at most one price coefficient. Furthermore, since the FROM1977 dummy variable leaves so small a proportion of the variance in wheat supply prices unexplained, it is questionable whether any explanatory price variable is truly significant.

Table 7.39 shows the outcome of a stricter test of the significance of the proposed explanatory variables. The residuals (error terms) from the first equation in Table 7.38 were regressed on lagged wheat trade prices and on the rice supply price. Thus the equations in Table 7.39 measure the explanatory power of the lagged wheat trade price variables and the rice supply price variable after the influence of the 1977 step increase in wheat supply prices has been removed. Now the supply price of rice is seen as clearly superior in its explanatory power to either measure of the lagged trade price of wheat. The rice supply price explains just under 60 percent of the year-to-year fluctuations in the logarithm of the wheat supply price (aside from the 1977 step increase), whereas either measure of the lagged wheat trade price explains less than 30 percent of this variance. Moreover, when the rice supply price and a lagged wheat trade price are both included in a regression equation, the coefficient for the rice supply price remains fairly stable and significant, while the coefficient for the lagged wheat trade price reverses sign and becomes insignificant. In short, the results reported in Table 7.39 support the acceptance of the rice supply price as an explanatory variable, and they support the rejection of the lagged wheat trade price as an explanatory variable.

Table 7.40 shows that it would be inappropriate to include a lagged trade price variable in the regression equation simulating the rice diversion payment. Table 7.41 confirms that JPQERIF6 has the best lag structure for simulating the rice diversion payment.

The quantity of rice used as feed or exported was regressed only on past excess rice production, since the sole purpose of that program was to dispose of past excess rice production. Table 7.42 compares coefficients for past excess production specified with various lag structures. 19/ The most statistically significant lag structure was not JPQERIF6, as used in the model, but instead the average level of excess rice production during the previous 5 fiscal years, or JPQERIF5. The complete nonlinear regression equation in JPQERIF5 is:

$$\begin{array}{llll} \text{JPQFXRIF} = & 110.52239734 & * \; \text{EXP(} & 0.0021022250 * \text{JPQERIF5)} \\ & \pm\, 42.59974974 & & \pm\, 0.0002951247 \\ & (2.594) & & (7.123) \\ & 2.90\% & & 0.01\% \end{array}$$

Adjusted R^2 = 94.98 percent for 11 observations (JFY 1969-79)
Durbin-Watson statistic = 1.661
Autocorrelation of residuals = 0.129

* indicates multiplication

EXP is the exponentiation (e^x) operator

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

JPQERIF5 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 5 fiscal years (thousand metric tons, brown basis)

This equation was not selected for use in the model, for two reasons. First, it was considered desirable to use a uniform lag structure across all equations, unless there emerged compelling evidence to the contrary. The slightly better showing of JPQERIF5 in one policy equation could easily be due more to happenstance than to systematic cause. Second, when past excess rice production averages to zero, the equation used in the model predicts rice feed plus exports of 33 thousand metric tons. This is more realistic than the 111 thousand metric tons of feed plus exports predicted under the same circumstances by the equation with JPQERIF5.

To further explore the consequences of using the equation with JPQERIF5 instead of the equation with JPQERIF6, all parts of the model affected by the value of rice feed plus exports were simulated using the alternative formulation. The summary error statistics derived from the two sets of simulations are compared in Table 7.43. In dynamic simulations, switching to the alternative equation with JPQERIF5 reduces the average absolute value of the error term for rice feed plus exports by about 150 thousand tons (about 50 thousand tons for rice feed, about 100 thousand tons for rice net exports). However, the choice of equation has virtually no effect on the mean absolute value of the residuals for corn feed and for corn net imports. If one judges by percent errors instead of judging by errors, then the dynamic simulations based on the alternative equation with JPQERIF5 predict rice feed and exports less well than the model's dynamic simulations. This is because the model's equation does a better job of simulating small quantities of rice feed plus exports (the misspecification of small numbers can lead to large percent errors). The choice of equation to predict rice feed plus exports makes little difference in the average absolute value of the percent errors in the simulation of corn feed and corn net imports (just as it makes little difference in the average absolute value of those errors measured in thousand metric tons). The overall conclusions are that the model's formulation does a better job of simulating small values of rice feed and exports, a worse job of simulating large values of rice feed and exports, and about an equally good job of estimating corn feed and corn imports.

Table 7.39--Regression equations for the residuals when the logarithm of the wheat supply price is estimated by regression on a dummy variable

Regression statistics	Intercept	ln(Wheat trade price, previous year) JPLPTWH1	ln(Wheat supply price/ trade price, prev.yr) JPLPSTW1	ln(Rice supply price) JPLPSRI	Comments
29.11% 1.877 .056	-0.095 ± .042 (2.3) 5.1%	0.031 ± .014 (2.3) 5.0%			Weak $\overline{R}^2$.
18.55% 1.857 .063	0.022 ± .013 (1.7) 12%		-0.021 ± .011 (1.8) 10%		Poor $\overline{R}^2$, weak coefficient for wheat supply/trade price ratio.
59.22% 2.516 -.274	-1.4 ± 0.4 (3.9) 0.34%			0.29 ± .07 (3.9) 0.34%	
55.06% 2.604 -.326	-1.6 ± 0.6 (2.6) 3.0%	-0.008 ± 0.19 (0.41) 69%		0.34 ± .14 (2.5) 3.8%	Wrong sign for wheat trade price.
54.88% 2.590 -.318	-1.6 ± 0.6 (2.8) 2.2%		0.004 ± .012 (0.37) 72%	0.32 ± .11 (2.9) 2.1%	Wrong sign for wheat supply/trade price ratio.

All regressions were run over the 11-year interval spanning Japanese fiscal years 1969-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: RESLPSWH = Japan, residual for the logarithm of the wheat supply price (1970 yen per kilogram), when it is estimated by the first regression equation in Table 7.38

Independent variables: JPLPTWH1 = Japan, logarithm of trade price for wheat, No. 2 hard red winter ordinary protein, f.o.b. U.S. Gulf ports, previous calendar year (1970 yen per kilogram)

JPLPSTW1 = Japan, logarithm of ratio: (wheat supply price) / (wheat trade price), previous year

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 7.40--Regression equations for the rice diversion payment

Regression statistics	Intercept	Ave. excess rice productn, previous 6 yrs JPQERIF6	ln(Rice supply price/ trade price, prev.yr) JPLPSTR1	Comments
-9.43% 0.776 .566	5.5 ± 0.2 (24) 0.01%		0.08 ± 0.23 (0.37) 72%	Insignificant $\overline{R}^2$ and coefficient for rice supply/trade price ratio.
86.66% 1.795 -.058	5.17 ± 0.06 (91) 0.01%	0.00063 ± .00008 (8.1) 0.01%		EQUATION USED IN MODEL.
85.03% 1.791 -.053	5.18 ± 0.09 (55) 0.01%	.00063 ± .00008 (7.6) 0.01%	-0.012 ± .085 (0.14) 90%	Wrong sign for rice supply/trade price ratio.

Regression statistics	Intercept	Time trend YEAR	Comments
14.97% 1.089 .253	72 ± 40 (1.8) 11%	-0.034 ± .020 (1.7) 13%	Poor $\overline{R}^2$, weak coefficient for time.

All regressions were run over the 11-year interval spanning Japanese fiscal years 1969-79.

The t-statistics are the coefficients divided by their standard errors, a relationship sometimes obscured by rounding.

Dependent variable: JPLDPRI = Japan, logarithm of rice diversion payment (thousands of 1970 yen per hectare)

Independent variables: JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPLPSTR1 = Japan, logarithm of ratio: (rice supply price) / (rice trade price), previous year

YEAR = Japanese fiscal year (values from 1969 to 1979)

The "Regression statistics" cells contain:

$\overline{R}^2$ = adjusted R^2 statistic, in %	
Durbin-Watson statistic	First-order autocorrelation

The other numerical cells contain:

Coefficient ± Standard error	
(Absolute value of t-statistic)	Significance level, in %

Source: Model estimates.

Table 7.41--The effect of alternative lag specifications on regression equations for the rice diversion payment

Period over which excess rice production averaged	Adjusted R^2 statistic	Coefficient for past excess rice production	$\pm$	Standard error	(t-statistic)	Significance level
1 to 4 years ago	37.87%	0.00025	$\pm$	.00009	(2.7)	2.6%
1 to 5 years ago	75.74%	0.00044	$\pm$	.00008	(5.7)	.03%
1 to 6 years ago	86.66%	0.00063	$\pm$	.00008	(8.1)	.01%
1 to 7 years ago	44.27%	0.00065	$\pm$	.00022	(3.0)	1.5%
2 to 4 years ago	60.17%	0.00025	$\pm$	.00006	(4.0)	.30%
2 to 5 years ago	76.93%	0.00033	$\pm$	.00006	(5.9)	.02%
2 to 6 years ago	69.58%	0.00040	$\pm$	.00008	(4.9)	.09%
2 to 7 years ago	28.13%	0.00035	$\pm$	.00016	(2.2)	5.4%

Notes: Regression equations include coefficients not listed in this table.

Each t-statistic is expressed in terms of its absolute value.

Source: Model estimates.

Table 7.42--The effect of alternative lag specifications on regression equations for the quantity of rice used as feed or exported

Period over which excess rice production averaged	Adjusted R^2 statistic	Coefficient for past excess rice production	$\pm$	Standard error	(t-statistic)	Significance level
1 to 4 years ago	77.69%	0.0013	$\pm$	.0004	(3.1)	1.3%
1 to 5 years ago	94.98%	0.0021	$\pm$	.0003	(7.1)	.01%
1 to 6 years ago	92.99%	0.0037	$\pm$	.0008	(4.9)	.09%
1 to 7 years ago	62.52%	0.0027	$\pm$	.0018	(1.5)	16%
2 to 3 years ago	75.27%	0.0009	$\pm$	.0003	(2.8)	1.9%
2 to 4 years ago	93.54%	0.0012	$\pm$	.0002	(6.6)	.01%
2 to 5 years ago	91.18%	0.0013	$\pm$	.0002	(5.4)	.04%
2 to 6 years ago	78.24%	0.0015	$\pm$	.0005	(3.0)	1.5%

Notes: Regression equations include coefficients not listed in this table.

Each t-statistic is expressed in terms of its absolute value.

Standard errors, t-statistics, and significance levels are approximate (valid only as asymptotic limits).

Source: Model estimates.

Table 7.43--Comparison of the summary error statistics produced by two specifications of the equation simulating the quantity of rice used as feed or exported

Variable	Duration of excess rice production used to simulate JPQFXRIF	Static simulation: Residual: Mean absolute value	Static simulation: Residual: Root mean square	Static simulation: Residual / actual: Mean absolute value	Static simulation: Residual / actual: Root mean square	Dynamic simulation: Residual: Mean absolute value	Dynamic simulation: Residual: Root mean square	Dynamic simulation: Residual / actual: Mean absolute value	Dynamic simulation: Residual / actual: Root mean square
	Years	Thousand metric tons		--- Percent ---		Thousand metric tons		--- Percent ---	
JPQFXRIF = Rice feed + exports	5	179	218	593	1,416	201	290	745	1,874
	6	213	257	396	848	352	469	464	1,125
JPQFRIFY = Rice used as feed	5	96	144	594	1,417	126	208	745	1,872
	6	82	121	396	847	170	268	464	1,127
JPQTRIFY = Rice net exports	5	84	114	77	150	80	114	95	203
	6	137	184	49	57	189	248	69	91
JPQARIFY = Add'ns to rice stocks	5	--	--	--	--	618	871	575	1,554
	6	--	--	--	--	767	1,010	632	1,632
JPQFCNFY = Corn used as feed	5	--	--	--	--	306	394	4.2	5.2
	6	--	--	--	--	301	383	4.2	5.0
JPNQMCNF = Corn net imports	5	--	--	--	--	497	591	5.6	6.2
	6	--	--	--	--	499	635	5.5	6.9

Note: The quantity of rice feed plus exports was simulated by one of the following two equations:

JPQFXRIF = ROUND (110.5 * EXP [0.0021 * (Average excess rice production during the previous 5 years)])

JPQFXRIF = ROUND (33.3 * EXP [0.0037 * (Average excess rice production during the previous 6 years)])

where * indicates multiplication, ROUND(x) equals x rounded to the nearest integer, and EXP[x] equals e^x. The coefficients in these equations are reported more precisely on pages 227 and 262.

Source: Model simulations.

1/ Calculated from data in MAFF, Statistical Yearbook, 1979/80 edition, pages 16-17.

2/ Calculated from data in MAFF, Statistical Yearbook, 1979/80 edition, page 517.

3/ Eric Saxon and Kym Anderson, Japanese Agricultural Protection in Historical Perspective (Research Paper No. 92, Australia-Japan Research Centre, the Australian National University, Canberra, 1982), Appendix Table B.

4/ Compare Tables 2.12 and 2.15.

5/ For a more detailed description of this subject, see William T. Coyle, Japan's Rice Policy (Foreign Agricultural Economic Report 164, Economics and Statistics Service, U.S. Dept. of Agriculture, July 1981).

6/ The current level of rice stocks, rather than the past flow of excess rice production, might have been used to predict government actions. Statistical difficulties preclude this. The only available stock level data refer to government inventories held by the Japanese Food Agency. The changes in stocks reported in the Japanese food balance sheets include privately held stocks as well as government stocks. Hence there is no way of relating the changes in stocks reported in the food balance sheets to the levels of stocks reported by the Japanese Food Agency. In an interview with the officials at MAFF who compile the food balance sheets (December 14, 1983), the author confirmed that MAFF collects data on private stock changes, but no data on private stock levels.

7/ The dynamic estimates of excess rice production reported in Table 7.3 differ from those previously reported in Table 6.3 because the switch from actual to estimated values occurs in 1969 for Table 7.3, but in 1965 for Table 6.3.

8/ These figures are calculated as:

$$12 = 1 / 0.081751681$$

and as:

$$131 = \mathrm{LOG}(0.99) / (-0.000076446142) = (-0.01) / (-0.000076446142)$$

where LOG(x) is the natural logarithm of "x".

9/ For a review of this terminology, see page 112.

10/ So-called dummy variables are used to measure the influence of "yes or no" factors; typically they can equal only 0 or 1. In contrast, ordinary variables measure the influence of "more or less" factors, and typically can equal a continuous range of values.

11/ Shortly before publication of this document, too late to influence the model's equations, the author clarified his understanding of wheat and barley prices during the mid-seventies. In 1973, grain trade prices rose explosively. For example, the U.S. Gulf port price for wheat in 1973 was

double the 1972 level (Table 2.10), corresponding to a 60 percent rise in the constant-yen price after adjustment for movements in the exchange rate and the general level of inflation (Table 2.12). Anticipating continued high trade prices, the Japanese government decided to give domestic producers a bonus payment of 2,000 yen per 60-kilogram bag of wheat or barley, effective the next crop year (1974). This bonus was paid in addition to the official producer price (which also rose sharply in 1974). It is not entirely clear why the government instituted a separately paid bonus instead of raising the supply price by an additional 2,000 yen per bag. Two possible motives are that a "bonus" would be politically easier to reduce or abolish in later years than an increase in the base price, which farmers would tend to consider a permanent entitlement; and that payments of the bonus were recorded in a different budget category than payments of the producer price, which may have cosmetically improved the government's accounts. The bonus payment remained at 2,000 yen per bag in fiscal 1975, then was raised to 2,300 yen in 1976. Starting in 1977, the bonus--still 2,300 yen--was included in the official producer price. Thus the apparent jump in wheat and barley supply prices in 1977 was primarily an accounting change, officially recognizing a disguised price increase that had started in 1974 as a consequence of the 1973 world grain crisis.

Sources for this analysis are a personal communication from Eric Saxon of the Australia-Japan Research Centre at the Australian National University, Canberra; and reports from the U.S. Agricultural Attaché's Office in Tokyo, numbered JP3040 (September 7, 1973), JP4004 (January 25, 1974), JP4041 (August 8, 1974), JP5002 (January 29, 1975), JP7005 (January 27, 1977), JP7044 (August 12, 1977), and JP0199 (August 22, 1980--the translation of an interview of Agriculture-Forestry-Fisheries Minister Kameoka published in Nihon Nogyo Shimbun indicates that it is far easier to discontinue special incentive payments than to lower producer prices).

Researchers wishing to modify the wheat and barley price series reported in Table 2.15 on the basis of information in this note should be aware of several problems: First, there were various price incentives in addition to those discussed here (see JP7005 and JP7044). Second, the Agricultural Attaché reports do not specify whether bonus payments applied to 52.5-kilogram bags of common barley as well as to 60-kilogram bags of naked barley; and if so, whether the bonus was smaller for the lighter bags. Third, Agricultural Attaché Reports JP6003 (January 27, 1976) and JP6043 (August 10, 1976) contradict each other, JP7005, and JP7044 on the size of bonus payments.

12/ Calculated as: $1/3 = e^{0.29256536} - 1$.

13/ Calculated as:

$$16 = LOG(1.01) / (0.00062983556) = 0.01 / (0.00062983556)$$

where LOG(x) is the natural logarithm of "x".

14/ The larger the number of observations used to estimate a nonlinear regression equation, the more accurate are these approximations. But 11 observations is not a large number.

15/ The nonlinear regression was estimated using the Gauss-Newton option of PROC NLIN in the Statistical Analysis System (SAS) program (see Note 2 of Chapter Three). Starting points for the nonlinear regression were obtained from a linear regression of the logarithm of rice surplus disposal on the average quantity of excess rice production during the previous 6 years. The nonlinear regression equation was then re-estimated with the variable JPQERIF6 divided by 100, to obtain two more digits for its coefficient. Statistics not reported by PROC NLIN were derived from reported statistics as follows:

Degrees of freedom =
(Number of observations) - (Number of regression coefficients)

Unadjusted R^2 = (Sum of squares from regression) /
(Sum of squares from regression + Sum of squares from residual)

Adjusted R^2 =
(Unadjusted R^2) - [1 - (Unadjusted R^2)] / (Degrees of freedom)

t-statistic = (Coefficient) / (Standard error)

Significance level = $1 - P_t$

where P_t is the two-tailed probability for a t-statistic with 9 degrees of freedom. The t-statistic probabilities were calculated using the TTEST option of the PROB command in the ABSTAT statistical package for microcomputers, Version 3.01, published by Anderson-Bell, Box 191, Canon City, CO 81212. Other statistics were calculated as follows:

Durbin-Watson statistic = (Sum of squared differences of
this year's residual minus the previous year's residual)
/ (Sum of squares of each year's residual)

Autocorrelation of residuals = (Sum of products of
this year's residual multiplied by the previous year's residual)
/ (Sum of squares of each year's residual)

In the ratios defining the last two statistics, "this year" ranges over 1970-79, "the previous year" ranges over 1969-78, and "each year" ranges over 1969-79. For calculating the Durbin-Watson statistic and autocorrelation, simulated values and their residuals are not rounded to the nearest thousand metric tons.

16/ The result follows from the fact that: EXP(0) = 1.

17/ Calculated as:

2.7 = LOG(1.01) / (0.0036978365) = 0.01 / (0.0036978365)

where LOG(x) is the natural logarithm of "x".

18/ The dynamic estimates reported in Tables 7.15 to 7.35 differ slightly from dynamic estimates reported in Chapters Five and Six. In the calculations underlying the previously reported estimates, the switch from actual to estimated lagged values occurred in 1965 (instead of 1969).

19/ Statistics appearing in Table 7.42 were derived by the methods described in Note 15 above.

CHAPTER EIGHT

PROJECTIONS TO 1992

SUMMARY

The equations of the Japanese Grains Model were calibrated with historical data, mostly from 1965-79. This chapter presents more recent data, projects the model's exogenous variables (time, population, income, and grain trade prices) to 1992, and defines three alternative policy scenarios. Then the entire model is projected over 1982-92 for each policy option. All scenarios indicate a major rice surplus by the end of the projections period. The last section of this chapter discusses possible approaches to reducing that surplus.

Projections of Exogenous Variables

The model's projections ultimately depend on forecasts of a few exogenous variables (that is, variables whose values are not determined by the model itself). These are the passage of time, population growth, national income, and international trade prices. Population projections are derived from forecasts published by the Japanese Prime Minister's Office. Japan's real (inflation-adjusted) gross national product, starting from its actual level in fiscal 1983, is forecast to grow by 3.8 percent annually through 1986, and then by 4.0 percent annually through 1992. These income growth rate assumptions are taken from the December 1983 edition of the Economic Research Service's baseline projections. The real trade prices of rice, wheat, corn, and sorghum are projected to change from their actual 1983 levels at the same rates as the baseline projections for real U.S. farm prices. This is equivalent to assuming that trade prices will parallel U.S. farm prices, and that fluctuations in the yen-per-dollar exchange rate will just compensate for differences in the rate of inflation across the two countries.

Assumptions for Policy Variables and New Policy Equations

The model's projections also depend on future Japanese agricultural policies. The policy assumptions made here do not imply that the author or the U.S. Government would either support or oppose such measures. Instead, three scenarios are designed to delineate the likely range of future behavior by the Japanese government, producers, and consumers.

Obtaining reasonable projections requires a few additions and modifications to the set of equations modeling surplus rice disposal. In the previous chapter, "excess rice production" was defined as rice production minus seed and food demand. Two limits are now imposed on the amount of surplus rice disposal in any year. It may not be more than twice the average quantity of excess rice production during the past 6 years. Also, rice disposal in the current year, added to rice disposal during the previous 7 years, may not be more than expected excess production during the current year, added to actual excess production during the previous 7 years. For this purpose, expected excess production during the current year is calculated as the average quantity of excess rice production during the past 6 years. Both limits on rice disposal are not allowed to fall below 36 thousand metric tons. Thus the model specifies:

Behavioral (Policy) Equations:

[94] LIMIT1 = MAX(36, 2 * JPQERIF6)

[95] LIMIT2 = MAX(36, JPQERIF6
+ JPQERI1F + JPQERI2F + JPQERI3F + JPQERI4F + JPQERI5F + JPQERI6F + JPQERI7F
- JPQFXRI1 - JPQFXRI2 - JPQFXRI3 - JPQFXRI4 - JPQFXRI5 - JPQFXRI6 - JPQFXRI7)

where:

* indicates multiplication

MAX(a,b) denotes the maximum of "a" and "b"

and where:

LIMIT1 = short-term limit on surplus rice disposal (thousand metric tons, brown basis)

LIMIT2 = long-term limit on surplus rice disposal (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPQERInF = Japan, excess of rice production net of seed used over rice food demand, "n" fiscal years ago (thousand metric tons, brown basis)

JPQFXRIn = Japan, rice used as feed or exported "n" fiscal years ago (thousand metric tons, brown basis)

The amount of surplus rice disposal is then modeled by a behavioral equation originally presented in Chapter Seven, combined with the two limits defined here. Equation [89a] is used to project future values, replacing Equation [89] which served to simulate past values.

Behavioral (Policy) Equation:

[89a] JPQFXRIF = MIN(LIMIT1, LIMIT2,
ROUND[33.30582914 * EXP(0.0036978365 * JPQERIF6)])

where:

MIN(a,b,c) denotes the minimum of "a", "b", and "c"

ROUND[x] rounds off "x" to the nearest integer

EXP is the exponentiation (e^x) operator

and where:

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

LIMIT1, LIMIT2, and JPQERIF6 are defined as above

The allocation of surplus rice disposal between subsidized feed and subsidized exports is modeled as follows: If the quantity of surplus rice disposal is no more than 50 thousand metric tons, then all of it will be allocated to feed. Beyond that, up to 400 thousand metric tons of rice will be exported. These rules are embodied in the following policy equation and identity:

Behavioral (Policy) Equation:

[96] JPQXRIFY = MIN(400, MAX(0, JPQFXRIF - 50))

Identity:

[97] JPQFRIFY = JPQFXRIF - JPQXRIFY

where:

JPQXRIFY = Japan, rice gross exports, fiscal year (thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year (thousand metric tons, brown basis)

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

The projections incorporate the assumption that subsidized rice feed displaces coarse grains in general, without affecting the ratio of corn to other coarse grains. This entails modifications to a set of equations from Chapter Four (where it was assumed that during the early years of the rice disposal program, subsidized rice feed displaced only corn). The ratio of the trade price of sorghum to the trade price of corn continues to determine the ratio of feed demand. The modified equations are listed in their revised logical order below:

Behavioral Equation:

[17a] JPLFBOCN = - 0.267836 - 1.951884 * JPLPTSCN

Identities:

[22a] JPQFBOCN = EXP(JPLFBOCN)

[24a] JPQFTCFY = JPQFNWFY - JPQFRIFY

[23a] JPQFCGFY = ROUND(JPQFTCFY * JPQFBOCN / (1.0 + JPQFBOCN))

[25a] JPQFCNFY = JPQFTCFY - JPQFCGFY

where:

JPLFBOCN = Japan, logarithm of ratio:
(barley + other grain feed) / (corn feed), fiscal year

JPQFBOCN = Japan, ratio:
(barley + other grain feed) / (corn feed), fiscal year

JPLPTSCN = Japan, logarithm of trade price ratio: (sorghum) / (corn), calendar year

JPQFaaFY = Japan, quantity of aa used as feed, fiscal year (thousand metric tons); with aa from the list:

CN = corn
CG = other coarse grains
TC = total coarse grains
NW = nonwheat grains
RI = rice

The projections describe the implications of three policy scenarios. All scenarios model surplus rice disposal as described above, and all assume that rice gross imports will remain at 33 thousand metric tons per year. The scenarios differ in their assumptions on how the government determines supply prices and the rice diversion payment.

The "surplus management" scenario assumes that the policy equations derived in Chapter Seven will continue to determine real grain prices and the real rice diversion payment. Thus government behavior is modeled primarily as a function of the amount by which net rice production has exceeded food demand during the previous 6 years. In this model (as seems close to being true in reality), the rice diversion payment has no effect on areas, yields, or production. Therefore the wholly implausible projections of the diversion payment under the surplus management scenario are harmless artifacts. The "constant prices" scenario freezes real supply prices and real diversion payments at their actual levels in 1983. Under the "budget squeeze" scenario, real supply prices and real diversion payments decline by 2 percent per year from their actual levels in 1983. These three scenarios span a plausible range of government price policies.

Projections of Endogenous Variables

Tables 8.10 to 8.27 and the accompanying graphs (on pages 296-334) show the projected values for every variable calculated by the model. Some projection results are worth highlighting.

Japan is expected to import just under 6 million metric tons of wheat in 1992, and 28 to 30 million metric tons of coarse grains. The model's projections split the coarse grain total into about 18 million tons of corn and 11 million tons of other coarse grains (likely to be almost all sorghum). Examining plots of past trends, however, indicates that 2 or 3 million tons of projected imports probably should be shifted into the corn category from the other coarse grains category.

Within Japan, the gross area planted is projected to fall from 5.6 million hectares in 1982 to 4.6 or 4.7 million hectares in 1992. The area sown to the country's main crop, rice, is projected to contract slightly, from 2.3 million hectares in 1983 to 2.0 or 2.1 million hectares in 1992. The reduction in rice area should be more than offset by increased yields--which are projected to rise from 4.56 metric tons per hectare in 1983 (a figure depressed by bad weather), to 5.75 metric tons per hectare in 1992 (assuming normal weather then). Japan's per capita rice consumption is dwindling by 2 percent each year; its population is growing by less than 1 percent per year. Thus total food demand for rice is decreasing. But rice production has an increasing trend (interrupted in the last few years by bad weather). This combination of demand and supply trends is projected to lead to a crisis of excess rice production in the late eighties and early nineties. In 1992, food consumption is projected at 9.2 million metric tons, while rice production net of seed is projected at 11 or 12 million metric tons. By that year, the government is projected to be disposing of between 3 and 5 million metric tons of previously accumulated surplus rice stocks. It is likely to export, in the form of subsidized food aid, as much rice as it can without seriously antagonizing its trading partners. (In this model, rice exports are limited to 400 thousand metric tons by assumption, partly offset by 33 thousand metric tons of specialty rice imports.) The rest of the disposed rice will be subsidized for use as feed within Japan, displacing coarse grain imports.

While it is theoretically possible for Japan to eliminate surplus rice production by 1992, the drastic changes in agricultural policies that would be required are not likely to be politically acceptable.

The ratio of the domestic supply price to the trade price is one measure of the degree of protectionism. In these projections, this ratio remains fairly steady (and very high) for rice, going from 4.6 in 1983 to between 4.0 and 4.8 in 1992. For wheat, the ratio of the domestic price to the foreign price increases from 4.9 in 1983 to between 5.4 and 6.5 in 1992, mainly due to a large projected drop in the trade price. (The projected wheat trade price falls by 24 percent between 1983 and 1992, while the projected domestic price in 1992 is from little changed to 17 percent lower.) Despite the vast disparity between the domestic and world wheat prices, Japan is expected to continue importing more than 90 percent of the wheat it consumes. Feed imports are a free trade item, a feature that virtually eliminates local production of coarse grains for feed.

REVIEW OF RECENT DATA

The formulation of equations for the model took longer than its author cares to admit. At a certain stage, the collection of data used to calibrate the equations was "frozen". Now more recently published statistics are brought into evidence, so that projections can be based on the latest available information.

At the time this was written (in the fall of 1984), the latest published food balance sheet was for fiscal 1982. Table 8.1 presents data from the 1980, 1981, and 1982 food balances. Tables 8.2 and 8.3 show recent values for macroeconomic variables. As noted in Chapter Two, GNP statistics published since the 1981 edition of the Japan Statistical Yearbook differ from the previously published GNP series used to calibrate the model. A complete

Table 8.1--Recent food balance sheets for grains

Crop / Fiscal years	Quantity supplied	Quantity used as seed	Quantity imported	Quantity exported	Net quantity traded	Additions to stocks	Quantity used as feed	Quantity used as food
				Thousand metric tons				
Rice								
1980	9,751	88	27	754	727	-2,185	4	11,117
1981	10,259	92	67	716	649	-1,712	198	11,032
1982	10,270	96	61	348	287	-1,834	838	10,883
Wheat								
1980	583	28	5,564	5	-5,559	88	647	5,379
1981	587	30	5,504	11	-5,493	46	663	5,341
1982	742	29	5,432	10	-5,422	129	627	5,379
Barley								
1980	385	12	2,087	0	-2,087	-86	1,518	1,028
1981	383	12	2,225	0	-2,225	49	1,532	1,015
1982	390	12	1,833	0	-1,833	-261	1,388	1,084
Corn								
1980	4	1	13,331	0	-13,331	237	10,615	2,482
1981	3	5	13,248	0	-13,248	-176	10,753	2,669
1982	2	5	14,206	0	-14,206	417	11,018	2,768
Other Grain								
1980	31	2	4,048	0	-4,048	44	3,923	110
1981	27	2	3,666	0	-3,666	-33	3,618	106
1982	29	3	3,395	0	-3,395	75	3,243	103

Notes: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Barley food usage can be subdivided between direct use (including waste) and industrial use as follows: 180 direct and 848 industrial in 1980; 143 direct and 872 industrial in 1981; 148 direct and 936 industrial in 1982.

Source: Japan, Ministry of Agriculture, Forestry and Fisheries, Statistical Yearbook, pages 500-501 in the 1982/83 edition and the equivalent table in earlier editions.

Table 8.2--Recent consumer price indices

Fiscal year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
1980/81	136.2	137.4	137.8	138.1	137.9	140.0	140.2	140.5	139.6	141.3	141.4	142.2
1981/82	104.3	105.2	105.3	105.0	104.4	106.1	106.5	106.2	106.5	106.5	106.2	106.4
1982/83	107.2	107.6	107.6	106.8	107.6	109.5	109.8	108.6	108.4	108.6	108.2	108.9
1983/84	109.3	110.5	109.7	109.2	108.9	110.3	111.3	110.6	110.3	110.6	111.3	111.6

Note: Data for the fiscal year 1980/81 are on a base of calendar-year 1975 = 100. Data for subsequent fiscal years are on a base of calendar-year 1980 = 100; dividing them by 0.729 converts to a base of 1975 = 100.

Sources: Japan, Ministry of Agriculture, Forestry and Fisheries, Monthly Statistics of Agriculture, Forestry and Fisheries, June 1984, page 9, and the equivalent table in previous issues; Japan, Prime Minister's Office, Monthly Statistics of Japan, April 1984, page 126, and the equivalent table in previous issues.

Table 8.3--Recent values of macroeconomic variables

Year	Consumer price index		Exchange rate (calendar year)	Population on October 1	Gross national product (fiscal year)		Real GNP per capita (fiscal year)	Adjusted real GNP (fiscal year)	
	Fiscal year	Calendar year			Nominal	Real		Total	Per capita
	Calendar 1975 = 100	Calendar 1970 = 1	Yen / dollar	Thousands	Billions of current yen	Billions of 1970 yen	Thousands of 1970 yen/capita	Billions of 1970 yen	Thousands of 1970 yen/capita
1980	139.4	2.364	226.74	117,060	240,647	100,713	860	101,972	871
1981	145.0	2.480	220.54	117,884	253,811	102,120	866	103,396	877
1982	148.5	2.546	249.05	118,693	267,351	105,032	885	106,345	896
1983	151.3	2.593	237.52	119,483	278,216	107,278	898	108,619	909

Note: Figures for income per capita shown here, unlike those used in model projections, are rounded.

Sources:

Consumer price indices: Fiscal-year statistics are calculated by averaging data from Table 8.2 over April-March periods, and dividing by 0.729 as needed to convert to a base of 1975 = 100. Calendar-year data are from Japan, Prime Minister's Office, Japan Statistical Yearbook, 1983, page 488; Monthly Statistics of Japan, June 1984, page 9; all divided by 42.3 to convert to a base of 1970 = 1.

Exhange rate: International Monetary Fund, International Financial Statistics, July 1984, pages 266-267, line rf.

Population: Japan, Prime Minister's Office, Japan Statistical Yearbook, 1983, page 25; Monthly Statistics of Japan, April 1984, page 11.

Gross national product: Nominal GNP for fiscal 1980 and 1981 are taken from Japan, Prime Minister's Office, Japan Statistical Yearbook, 1983, page 559; while nominal GNP for fiscal 1982 and 1983 are calculated as the sum of quarterly data reported in Monthly Statistics of Japan, July 1984, page 150. To obtain real GNP figures, nominal GNP statistics are deflated by fiscal-year CPI data in this table, then divided by 58.34 (to convert from 1975 = 100 to 1970 = 1).

Real GNP per capita: Population statistics in this table convert total GNP to GNP per capita.

Adjusted real GNP: To align recently published GNP statistics with the older GNP series which was used to calibrate the equations in the Japanese Grains Model, GNP statistics from the newer series are multiplied by 1.0125. The resulting adjusted real GNP statistics form a basis for model projections. See also Table 8.4.

comparison is given in Table 8.4. To bring the newer GNP series into approximate alignment with the older series, the new-series data were multiplied by 1.0125, producing the "adjusted GNP" statistics shown in Table 8.3. Table 8.5 reports on trade prices and their conversion into constant yen. Finally, Tables 8.6 to 8.8 display recent crop-related data: Japanese prices, diversion payments, areas, yields, production, and expected revenues. As before, expected revenue is defined as the previous year's supply price multiplied by the average of the previous 3 years' yields.

PROJECTED VALUES OF EXOGENOUS VARIABLES

The model adopts (and adapts) official Japanese population projections, taken as the most accurate available. These official projections are given at 5-year intervals; a constant percentage growth rate is used here to interpolate "unadjusted" values for intermediate years. New population data have become available since the official projections were made. Each year's unadjusted population projection has been increased by about 0.46 percent, so that the projected population in 1983, after adjustment, coincides with the actual 1983 population. The results of these calculations are reported in Table 8.9, together with a more detailed explanation of the method used.

Table 8.9 also shows projected values of the Japanese gross national product. Starting from the actual 1983 GNP, adjusted upwards by 1.25 percent to align it with the older GNP data, the real value of national income is projected to grow at the same rates as assumed in Economic Research Service baseline projections. 1/

The trade price projections displayed in Table 8.9 also start with actual values for 1983, and also assume rates of change derived from Economic Research Service baseline projections. In particular, the trade prices for rice, wheat, corn, and sorghum are assumed to change at the same rate as the baseline projections for U.S. farm prices expressed in constant dollars. This implies a series of additional assumptions: that U.S. export prices for grains will change in the same proportion as farm prices, that U.S. and Thai rice export prices will change in parallel, and that the exchange rate between U.S. dollars and Japanese yen will move so as to compensate for differences in the rates of inflation in the two countries. In these calculations, the baseline projections for U.S. farm prices are converted from crop years into calendar years by taking averages of adjacent crop-year statistics, weighted by the number of months in the calendar year coming from each crop year.

Several points regarding the trade price projections should be kept in mind. First, there was a general consensus among the analysts who prepared and reviewed the baseline projections for U.S. farm prices that they are best treated as rough approximations. Second, there was no consensus on whether it is more likely that the projected prices are too high or too low, with opinions about evenly split. Third, exchange rates are influenced by many factors aside from relative rates of inflation. Thus the method of converting projected U.S. real prices into projected Japanese real prices is imprecise. Fourth, no one has come up with a better method of predicting long-range movements in exchange rates. To summarize, the trade price projections presented in Table 8.9 should be regarded as educated guesses, representing a compromise between optimists and pessimists.

--Text continues to page 287.

Table 8.4--Comparison of older and newer GNP data series

Fiscal year	GNP data in older series	GNP data in newer series	Older series - Newer series	(Older series - Newer series) / Newer series
	Billions of current yen			Percent
1965	32,982	33,550	-568	-1.69
1966	38,873	39,452	-579	-1.47
1967	45,897	46,176	-279	-0.60
1968	54,577	54,689	-112	-0.20
1969	64,514	64,851	-337	-0.52
1970	75,524	75,092	432	0.58
1971	83,166	82,726	440	0.53
1972	96,884	96,424	460	0.48
1973	117,258	116,636	622	0.53
1974	139,219	138,045	1,174	0.85
1975	153,126	151,797	1,329	0.88
1976	171,815	170,290	1,525	0.90
1977	190,713	188,804	1,909	1.01
1978	209,248	206,763	2,485	1.20
1979	224,866	222,043	2,823	1.27

Sources:

Older series from Table 2.18, which in turn is based on Japan, Prime Minister's Office, Japan Statistical Yearbook, page 497 in the 1980 edition and the equivalent table in earlier editions, and its Monthly Statistics of Japan, January 1981, page 127.

Newer series from Japan, Prime Minister's Office, Japan Statistical Yearbook, 1983, page 559 (for recent years); and Japan, Ministry of Finance, Financial Statistics of Japan, 1983, page 7 (for early years).

Table 8.5--Recent trade prices

Calendar year	As originally reported				In dollars / metric ton				In 1970 yen / kilogram			
	Rice	Wheat	Corn	Sorghum	Rice	Wheat	Corn	Sorghum	Rice	Wheat	Corn	Sorghum
	Dollars/ met. ton	--- Dollars / bushel ---			------- Dollars / metric ton -------				------- 1970 yen / kilogram -------			
1980	433.67	4.70	3.19	3.38	433.67	172.70	125.58	133.06	41.59	16.56	12.05	12.76
1981	482.83	4.76	3.32	3.28	482.83	174.90	130.70	129.13	42.94	15.55	11.62	11.48
1982	293.38	4.36	2.75	2.81	293.38	160.20	108.26	110.62	28.70	15.67	10.59	10.82
1983	276.83	4.28	3.45	3.34	276.83	157.26	135.82	131.49	25.36	14.41	12.44	12.04

Note:

Wheat bushels weigh 60 pounds; corn and sorghum bushels weigh 56 pounds.

Sources:

Rice, wheat, and corn prices: International Monetary Fund, International Financial Statistics, July 1984, pages 72-75.

Sorghum price: U.S. Dept. of Agriculture, Agricultural Outlook, June 1984, page 39; June 1982, page 40.

Exchange rate and calendar-year consumer price index (used to convert dollars into 1970 yen): Table 8.3.

Table 8.6--Recent values of grain prices and the diversion payment in Japan

Fiscal year	Values in current yen							Values in constant yen						
	Resale prices			Supply prices			Diversion payment	Resale prices			Supply prices			Diversion payment
	Rice	Wheat	Barley	Rice	Wheat	Barley		Rice	Wheat	Barley	Rice	Wheat	Barley	
	Current yen / kilogram						Thousands of yen / hectare	1970 yen / kilogram						Thous. of 1970 yen / hectare
1980	264.85	60.78	51.30	292.27	178.40	161.66	550	110.84	25.44	21.47	122.32	74.66	67.66	230
1981	273.18	63.95	54.18	293.38	184.12	166.56	500	109.91	25.73	21.80	118.04	74.08	67.01	201
1982	283.88	64.40	54.56	296.62	184.12	166.56	500	111.53	25.30	21.43	116.53	72.33	65.44	196
1983	283.88	69.33	58.74	301.87	184.12	166.56	500	109.46	26.73	22.65	116.40	71.00	64.22	193
1984	294.55	69.33	--	308.42	184.12	166.56	420	--	--	--	--	--	--	--

Sources:

Resale Prices: Statistics through 1983 are based on data from Japan, Ministry of Agriculture, Forestry and Fisheries (MAFF), Statistical Yearbook, 1982/83, pages 602-603. Statistics for 1984 are based on U.S. Dept. of Agriculture (USDA), Foreign Agricultural Service (FAS), Report JA4012 (Tokyo to Washington: February 9, 1984), page 9. For wheat and barley, a 25 yen per bag packing charge has been added to the data published in the yearbook. For all grains, prices have been converted from yen per bag into yen per kilogram.

Supply Prices: Statistics through 1982 are based on data from Japan, MAFF, Statistical Yearbook, 1981/82, page 514. This table is omitted from the 1982/83 edition, and the similar data on pages 602-603 refer to different grades of grain. So statistics for 1983 and 1984 are based instead on USDA, FAS, Report JA4116 (Tokyo to Washington: June 22, 1984), page 1, which reports unchanged wheat and barley supply prices; and on Report JA4142 (Tokyo to Washington: August 13, 1984), page 2, using the price of Grade C of Class 1 rice. A slight incompatibility remains: all statistics through 1982 are net of packing fees, whereas the rice statistics for 1983 and 1984 include an unknown but presumably small packing fee. Price data from the yearbook have been converted from yen per bag into yen per kilogram.

Diversion payments: USDA, FAS, Report JA4025 (Tokyo to Washington: February 29, 1984), page 11. The diversion payment shown for 1984 is scheduled to remain the same through 1986, in terms of current yen (its value in constant yen will decline from inflation).

Price deflator: To calculate prices in constant 1970 yen, current prices are divided by the fiscal-year consumer price index series reported in Table 8.3, then divided by 58.34 (to convert from 1975 = 100 to 1970 = 1).

Table 8.7--Recent areas, production levels, and yields

Fiscal year	Area					Production			Yield		
	Gross total	Rice	Wheat	Barley	Other nonrice	Rice	Wheat	Barley	Rice	Wheat	Barley
	Thousand hectares					Thousand metric tons			Metric tons / hectare		
1980	5,636	2,377	191.1	122.2	2,946	9,751	583	385	4.10	3.05	3.15
1981	5,600	2,278	224.4	122.4	2,975	10,259	587	383	4.50	2.62	3.13
1982	5,590	2,257	227.8	122.9	2,982	10,270	742	390	4.55	3.26	3.17
1983	--	2,273	229.0	124.0	--	10,366	695	379	4.56	3.03	3.06

Notes:

Rice production statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Barley comprises two-row, six-row, and naked barley.

Sources:

Rice, wheat, and barley: Area and production data are from Japan, Ministry of Agriculture, Forestry and Fisheries (MAFF), Statistical Yearbook, 1982/83, pages 72-78; and its Monthly Statistics of Agriculture, Forestry and Fisheries, August 1984, page 10. Yields are calculated as production divided by area.

Gross total area: Japan, MAFF, Statistical Yearbook, 1982/83, page 112.

Other nonrice area: Calculated as gross total area minus rice, wheat, and barley areas.

Table 8.8--Recent values for expected revenues from grains

Fiscal year	Rice	Wheat	Barley	Average of wheat and barley	Average for three grains
	Thousands of 1970 yen per hectare				
1980	624	240	216	230	586
1981	564	248	227	240	526
1982	527	230	219	226	487
1983	511	215	206	212	471
1984	528	211	200	207	485

Note: Expected revenue is defined as the previous year's supply price times the average of the previous 3 years' yields.

Source: Calculated from constant-yen price data in Table 8.6 and yield data in Table 8.7.

Table 8.9--Projected values of exogenous variables for the Japanese Grains Model

Year	Population and income (fiscal year)			Real trade prices (calendar year)			
	Population on Oct. 1	Real GNP	Real GNP per capita	Rice	Wheat	Corn	Sorghum
	Thousands	Billions of 1970 yen	Thous. of 1970 yen / capita	------- 1970 yen / kilogram -------			
1984	120,167	112,746	938	26.61	13.28	13.47	12.64
1985	120,855	117,030	968	25.80	11.63	10.85	10.56
1986	121,360	121,477	1,001	25.04	10.93	9.92	9.77
1987	121,867	126,336	1,037	25.29	10.67	9.54	9.28
1988	122,375	131,389	1,074	26.30	10.59	10.38	10.17
1989	122,887	136,645	1,112	26.99	10.41	9.82	9.68
1990	123,400	142,111	1,152	25.11	10.24	10.10	10.07
1991	123,908	147,795	1,193	24.17	10.59	9.73	9.87
1992	124,418	153,707	1,235	24.17	11.02	9.63	9.68

Sources and methods of calculation:

Population: Population projections at 5-year intervals, starting with 1980, were prepared by the Institute of Population Programs of Japan's Ministry of Health and Welfare in 1981. They are reproduced in Japan, Prime Minister's Office, Statistical Yearbook, 1983, page 25, with notes on pages 20-21. They include population estimates (in thousands) of 116,916 for 1980; 120,301 for 1985; 122,834 for 1990; and 125,383 for 1995. This author applied constant growth rates between the benchmark years to calculate "unadjusted" estimates at annual intervals--for example 118,935 thousand in 1983. Since the actual population in 1983 was 119,483 thousand (see Table 8.3), all of the unadjusted population projections were multiplied by 119,483/118,935 to produce the adjusted estimates shown in this table.

Income: Starting from its actual level in 1983 (reported in Table 8.3), adjusted real GNP is projected to grow by 3.8 percent per year through 1986; and to grow by 4.0 percent per year from 1987 through 1992. The projected growth rates are consistent with those listed in U.S. Dept. of Agriculture, Economic Research Service, Problems and Prospects for U.S. Agriculture: Baseline Projections for the Farm Sector to 1992 (December 1983, unpublished), Table III-2. The population projections in this table are used to convert projected GNP into projected GNP per capita.

Trade prices: Starting from their actual levels in 1983 (reported in Table 8.5), trade prices are assumed to change in the same proportions as the "real farm prices" for those crops shown in Tables V-1, V-2, V-3, and V-4 of the Baseline Projections cited above. These statistics are supplemented by data for the crop year 1982/83 from page V-3 of the Baseline Projections (wheat and corn), and from U.S. Dept. of Agriculture, Statistical Reporting Service, Agricultural Prices: 1983 Summary, pages 31-32 (rice and sorghum). Nominal prices for rice and sorghum in 1982/83 are converted into 1972 dollars using the implicit GNP price deflator published in U.S. Congress, Joint Economic Committee, Economic Indicators, June 1984, page 2. In all of these calculations, farm price data is converted from crop years (September/August for rice, July/June for wheat, and October/September for corn and sorghum) into calendar years by taking weighted averages of adjacent crop years. For example, the 1985 calendar-year price of rice is calculated as 2/3 of the 1984/85 crop-year price plus 1/3 of the 1985/86 crop-year price.

Should the reader wish to substitute other price projections, this report lists all the equations needed to transform projected grain trade prices into projected grain trade quantities. Changes in trade price projections have the following principal implications: First, it takes a 5 percent decline in the projected average price of corn and sorghum to induce a 1 percent increase in projected feed consumption. Second, each 1 percent increase in the projected price ratio of corn to sorghum leads to a 2 percent decline in the projected quantity ratio of corn feed to other coarse grain feed. Third, a given percentage change in the projected trade price of rice induces, one year later, a percentage change one-twelfth as large in the projected supply price of rice, and a percentage change one thirty-eighth as large in the projected supply prices of wheat and barley. Another year later, the altered supply prices cause projected grain yields, areas, and production to change by similarly tiny percentages. In short, the effects of a change in the trade price of rice on projected Japanese behavior are delayed and very small. Finally, the trade price of wheat does not affect any variable in the model. Wheat trade price projections are included in Table 8.9 only for completeness, and to accommodate readers who may wish to modify the wheat equations used in this model.

ASSUMPTIONS FOR POLICY VARIABLES

The projections require assumptions about future Japanese domestic agricultural policies. The effects of three policy scenarios will be investigated here, with no implication that the author or the U.S. Government would either endorse or condemn such policies. Instead, the scenarios are designed to encompass a plausible range of Japanese government actions, in order to delineate the likely range of future behavior by Japanese producers and consumers.

General Assumptions

All three scenarios have certain features in common. All presume that gross imports of rice will remain fixed at 33 thousand metric tons per year (maintaining an assumption introduced in the previous chapter). The dummy variable FROM1977 stays set to 1. All scenarios also specify the same policies for the disposal of surplus rice. In this part of the model, however, a few loose ends need to be nailed down. They concern limits on the amount of surplus rice disposal, the division of total disposal between subsidized exports and subsidized feed, and allocation of the effects of rice feed between displacement of corn and displacement of other coarse grains.

Due to the recent, sporadic, and changing nature of the rice disposal program, there is not sufficient evidence to form a basis for statistical inferences. The model's assumptions about rice feed and exports are plausible possibilities, not social-scientific measurements.

In the previous chapter, the amount of surplus rice disposal was modeled as an exponential function of past excess rice production:

```
JPQFXRIF  =  ROUND( 33.30582914  *  EXP( 0.0036978365 * JPQERIF6 ) )
```

where:

ROUND(x) rounds off "x" to the nearest integer

EXP is the exponentiation (e^x) operator

and where:

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

Exponential functions tend to "blow up": the predicted size of the explained variable grows explosively if the explanatory variable takes values significantly larger than those experienced during the historical period used to calibrate the equation. In these projections, the explanatory variable (excess rice production) does indeed grow beyond its historical range; and, if left unrestrained, the projected amount of surplus rice disposal would be absurd. Two limits are imposed to prevent projected rice disposal from attaining unreasonable levels.

The first is a short-term limit. In any year, rice disposal can be no more than twice as large as the average level of excess rice production during the previous 6 years. This limit becomes an effective constraint whenever projected rice disposal exceeds 2,287 thousand metric tons. (The sum of rice feed plus exports has surpassed this level only once, in 1971--see Tables 7.9 and 8.1.) To keep negative excess rice production from implying negative rice disposal, the minimum value allowed for LIMIT1 is 36 thousand metric tons. 2/ Thus:

LIMIT1 = MAX(36, 2 * JPQERIF6)

where:

* indicates multiplication

MAX(a,b) denotes the maximum of "a" and "b"

and where:

LIMIT1 = short-term limit on surplus rice disposal (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

Continuously selling off twice the average annual excess of rice production would ultimately deplete all accumulated stocks, and even force imports. To avoid projecting such behavior, the model includes a long-range limit to surplus rice disposal: this year's rice disposal plus the past 7 years'

disposal may not be greater than this year's estimated excess rice production plus the past 7 years' actual excess production (with this year's estimated excess production calculated as the average amount of excess rice production during the previous 6 years). In other words, the government is portrayed as balancing rice disposal with excess rice production over an 8 year horizon. 3/ The long-term limit, like the short-term limit, is not allowed to fall below 36 thousand metric tons. Its complete formulation is:

```
LIMIT2 = MAX( 36, JPQERIF6
  + JPQERI1F + JPQERI2F + JPQERI3F + JPQERI4F + JPQERI5F + JPQERI6F + JPQERI7F
  - JPQFXRI1 - JPQFXRI2 - JPQFXRI3 - JPQFXRI4 - JPQFXRI5 - JPQFXRI6 - JPQFXRI7 )
```

where:

MAX(a,b) denotes the maximum of "a" and "b"

and where:

LIMIT2 = long-term limit on surplus rice disposal (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

JPQERInF = Japan, excess of rice production net of seed used over rice food demand, "n" fiscal years ago (thousand metric tons, brown basis)

JPQFXRIn = Japan, rice used as feed or exported "n" fiscal years ago (thousand metric tons, brown basis)

Combining this chapter's limits with the previous chapter's equation for the quantity of surplus rice disposal, one obtains:

```
JPQFXRIF = MIN( LIMIT1, LIMIT2,
                ROUND[ 33.30582914 * EXP(0.0036978365 * JPQERIF6) ] )
```

where:

MIN(a,b,c) denotes the minimum of "a", "b", and "c"

ROUND[x] rounds off "x" to the nearest integer

EXP is the exponentiation (e^x) operator

and where:

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

LIMIT1 = short-term limit on surplus rice disposal (thousand metric tons, brown basis)

LIMIT2 = long-term limit on surplus rice disposal (thousand metric tons, brown basis)

JPQERIF6 = Japan, excess of rice production net of seed used over rice food demand, averaged over previous 6 fiscal years (thousand metric tons, brown basis)

Surplus rice disposal must be allocated between exports and feed. Subsidized Japanese rice exports have antagonized other countries. For the period 1980-84, the United States negotiated an agreement limiting rice exports to an average of 400 thousand metric tons per year. That agreement has now expired. In the meantime, a series of poor harvests caused by bad weather has allowed the Japanese Food Agency to get rid of accumulated surplus stocks. The government now expresses confidence that it will have no need to export rice in the foreseeable future, though it envisages using rice as feed after a return to normal weather and yields. Nevertheless, it is reasonable to surmise that if a large enough surplus of rice accumulates, some of it will be exported as food aid. It is also reasonable to surmise that subsidized exports will be kept within bounds, to limit their repercussions. In particular, these projections assume that once the government decides to dispose of a given quantity of surplus rice, then the first 50 thousand metric tons will be allocated to feed mills and any excess over 50 thousand tons will be exported, up to a maximum export level of 400 thousand metric tons. So for example, if the government decides to dispose of 40 thousand tons, then all will go into feed; if it decides to dispose of 80 thousand tons, then 50 thousand tons will be used as feed and the remaining 30 thousand tons will be exported; and if it decides to dispose of 500 thousand tons, then exports will be limited to 400 thousand tons, with the remaining 100 thousand tons used for feed. These allocation rules are embodied in the behavioral equation and identity below.

JPQXRIFY = MIN(400, MAX(0, JPQFXRIF - 50))

JPQFRIFY = JPQFXRIF - JPQXRIFY

where:

MIN(a,b) denotes the minimum of "a" and "b"

MAX(a,b) denotes the maximum of "a" and "b"

and where:

JPQXRIFY = Japan, rice gross exports, fiscal year (thousand metric tons, brown basis)

JPQFXRIF = Japan, rice used as feed or exported, fiscal year (thousand metric tons, brown basis)

JPQFRIFY = Japan, rice used as feed, fiscal year (thousand metric tons, brown basis)

In the early years of the rice disposal program, rice feed seems to have displaced corn feed on roughly a ton-for-ton basis. It was so modeled in

Chapter Four. More recently, rice feed appears to have substituted for sorghum as well as for corn. For making projections (unlike the model for past behavior), it is assumed that rice feed displaces both corn and sorghum, without affecting the ratio of corn feed to other coarse grain feed. Thus the following behavioral equation from Chapter Four:

JPLFBORC = - 0.267836 - 1.951884 * JPLPTSCN

is replaced by this equation for making projections:

JPLFBOCN = - 0.267836 - 1.951884 * JPLPTSCN

where:

JPLFBORC = Japan, logarithm of ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

JPLFBOCN = Japan, logarithm of ratio:
(barley + other grain feed) / (corn feed), fiscal year

JPLPTSCN = Japan, logarithm of trade price ratio: (sorghum) / (corn), calendar year

To correspond to the change in the behavioral equation, these four identities from the model of past behavior in Chapter Four:

JPQFBORC = EXP(JPLFBORC)

JPQFCGFY = ROUND(JPQFNWFY * JPQFBORC / (1.0 + JPQFBORC))

JPQFRCFY = JPQFNWFY - JPQFCGFY

JPQFCNFY = JPQFRCFY - JPQFRIFY

are now replaced by the following four identities for making projections:

JPQFBOCN = EXP(JPLFBOCN)

JPQFTCFY = JPQFNWFY - JPQFRIFY

JPQFCGFY = ROUND(JPQFTCFY * JPQFBOCN / (1.0 + JPQFBOCN))

JPQFCNFY = JPQFTCFY - JPQFCGFY

where:

JPQFBORC = Japan, ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

JPQFBOCN = Japan, ratio:
(barley + other grain feed) / (corn feed), fiscal year

JPLFBORC = Japan, logarithm of ratio:
(barley + other grain feed) / (rice + corn feed), fiscal year

JPLFBOCN = Japan, logarithm of ratio:
(barley + other grain feed) / (corn feed), fiscal year

JPQFaaFY = Japan, quantity of aa used as feed, fiscal year
(thousand metric tons); with aa from the list:

CN = corn
CG = other coarse grains
TC = total coarse grains
NW = nonwheat grains
RC = rice plus corn
RI = rice

Now that the common points of the three policy scenarios have been described, it is appropriate to define the differences between them.

"Surplus Management" Scenario

The basic scenario envisages a continuation of the policies described in the previous chapter, where it was shown that government behavior since fiscal 1969 can be modeled primarily in terms of an effort to cope with a tendency towards surplus production of Japan's dominant rice crop. Behavioral equations developed in Chapter Seven project supply prices throughout the projections period. (Trade prices are not determined by behavioral equations, but are taken as given by Table 8.9.)

"Constant Prices" Scenario

An assumption commonly used for making projections is that prices will remain unchanged. As implemented here, this scenario assumes constant real prices (in other words, it is assumed that the government will increase nominal prices just enough to keep up with inflation). The Japanese supply prices for rice, wheat, and barley, as well as the rice diversion payment, are maintained at their actual levels in fiscal 1983. Only these domestic prices are presumed to be frozen--real trade prices change as specified in Table 8.9.

"Budget Squeeze" Scenario

Japan's recent agricultural policies have been at high cost to its Treasury. The budget squeeze scenario assumes that a worsening budget problem will induce the government to raise nominal grain supply prices and the rice diversion payment more slowly than the rate of inflation, causing real prices and the real diversion payment to fall by 2 percent per year through 1992. Again, real trade prices are presumed to change as specified in Table 8.9.

To summarize, the surplus management scenario represents a continuation of past policies. The constant prices and budget squeeze scenarios are reasonable alternatives. It is the author's judgment, based on study of government policy papers and conversations with Japanese and American researchers from the government, academic, and private sectors, that these three scenarios span the likely range of Japanese grain policies over the next decade. 4/

Every equation and assumption is now in place. The resulting sets of projections are first tabulated by functional category (such as food consumption or supply price) in Tables 8.10 through 8.20, and then tabulated by commodity (such as rice or wheat) in Tables 8.21 through 8.27. Most variables are also graphed, in Figures 8.1 through 8.48.

There follows a brief commentary on most of the variables projected by the model. The discussion is mainly in terms of the graphs, since broad trends are more easily seen from graphs than from tables.

Supply Prices, Yields, and Expected Revenues

A series of poor harvests in recent years led to negative levels of excess rice production--that is, domestic supply was insufficient to meet food demand. Under the surplus management scenario, rice prices increase sharply in response to this history of deficit production (Figure 8.4). However, a return to normal weather implies a return to excess rice production, which gradually brings down prices. After 1990 the real price of rice is shown as falling below its 1983 level. The budget squeeze scenario, in contrast, implies a gradual but steady price decline which is more in line with long-term trends since 1975.

Projected wheat and barley supply prices (depicted in Figures 8.5 and 8.6) behave similarly to projected rice prices. This is because wheat and barley prices are a function of the price of rice in the surplus management scenario, and because all supply prices are assumed to move in parallel in the other two scenarios.

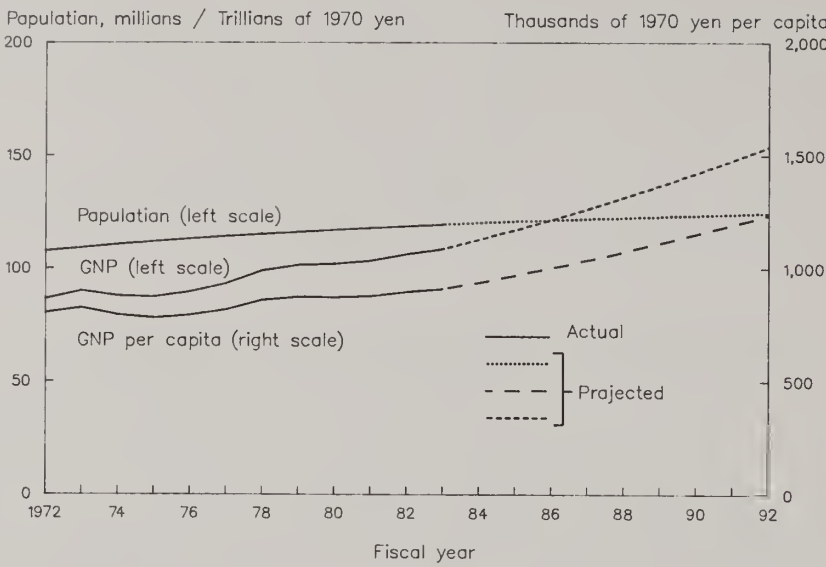
There is little to say about projected yields (Figures 8.21 to 8.23). All scenarios are reasonably consistent with previous trends. Since the projections abstract from abnormal weather, which has caused major yield fluctuations in the past, future yields appear much more uniform than their historical records.

Due to the flatness of the yield projections, patterns of projected prices are transformed with little distortion into patterns of projected expected revenue per hectare (Figures 8.24 to 8.27). For rice, the steady growth trend in projected yields twists the patterns of projected revenue upwards, compared to the price patterns. For wheat and barley, the expected revenue patterns diverge more between policy scenarios than do the price patterns, because the effects of price changes on revenue are multiplied by parallel changes in yield.

Rice Diversion Payments

The rice diversion payment goes "through the roof" in the surplus management scenario (Figure 8.7). It is clear that the Japanese government would not behave that way. Indeed, the nominal rice diversion payment for fiscal 1984 has been set at a lower level than it was in fiscal 1983; and it is scheduled to remain frozen in nominal terms through fiscal 1986. By 1986, the real value of the diversion payment will have been further eroded by inflation.

Figure 8.1
Actual and Projected Income and Population



Sources: Derived from Tables 2.17 and 2.18, Table 8.3 (using adjusted real GNP), Table 8.4 (using GNP data in old series), and Table 8.9.

Either the equation modeling the diversion payment was wrongly specified in Chapter Seven, or the equation was correct but the government is changing its pattern of behavior. Little would be gained from efforts to patch together a more realistic equation, since the relationship between diversion payments and grain production is statistically insignificant in reality and nonexistent in the model. Instead, one can just conclude that the policy equation for the rice diversion payment should not be used to make projections.

Food Demand

Food demand does not depend on supply prices, so it is the same under all scenarios (Figures 8.8 to 8.14). For rice, wheat, and corn, projected demand essentially follows past trends. The projected food usage of barley and of "other grain" seems slightly high.

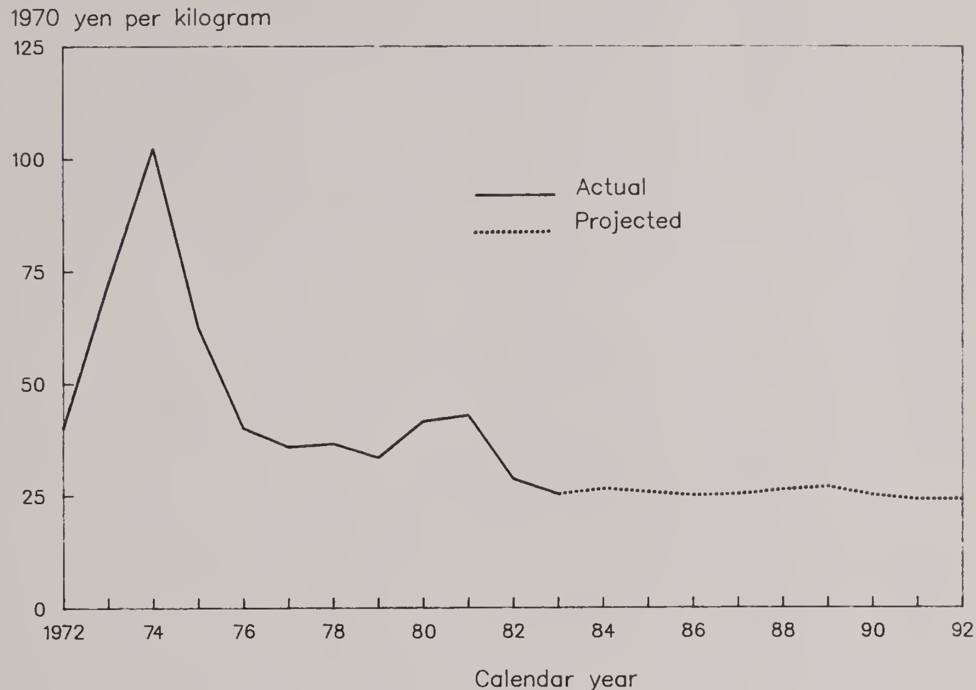
Feed Demand

Under all scenarios, total feed demand grows steadily towards 25 million metric tons in 1992, driven primarily by Japanese income growth, and secondarily by falling trade prices for corn and sorghum (Table 8.12 and Figure 8.15). The projections appear to underestimate demand for corn feed (Figure 8.18), and to overestimate demand for other coarse grain feed (Figure 8.19); but the projections for total coarse grain feed appear about right (Figure 8.20). Wheat feed usage may be underestimated (Figure 8.16), but the amounts involved are small enough that it makes little difference. Rice feed usage will be discussed later, in the section concerning the disposal of surplus rice.

--Text continues to page 315.

Figure 8.2

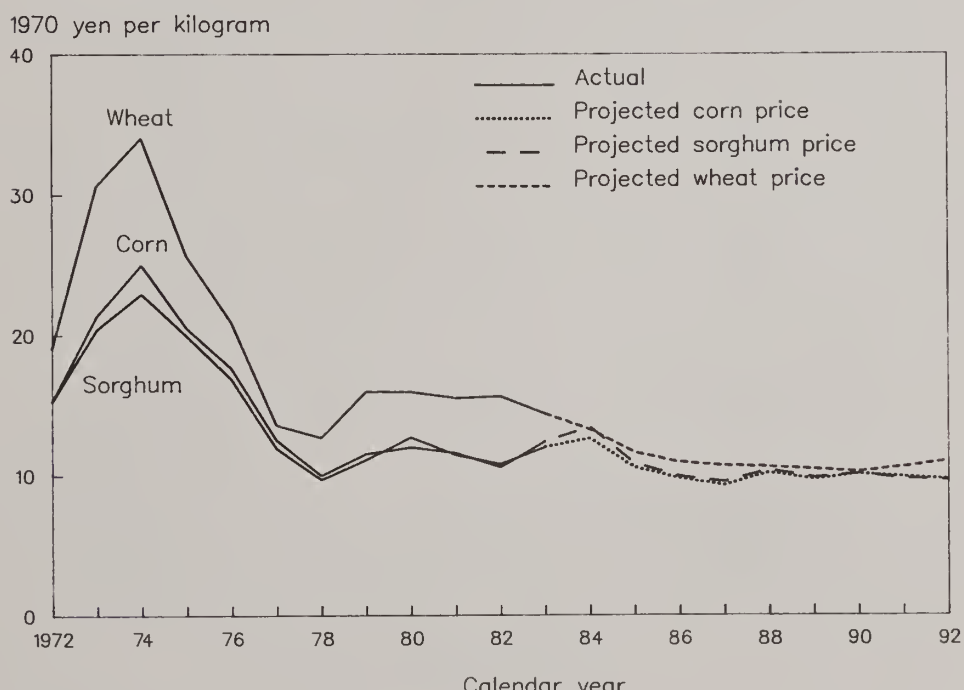
Actual and Projected Trade Price for Rice



Sources: Tables 2.12, 8.5, and 8.9.

Figure 8.3

Actual and Projected Trade Prices for Wheat, Corn, and Sorghum



Sources: Tables 2.12, 8.5, and 8.9

Table 8.10--Projected grain supply prices and diversion payments

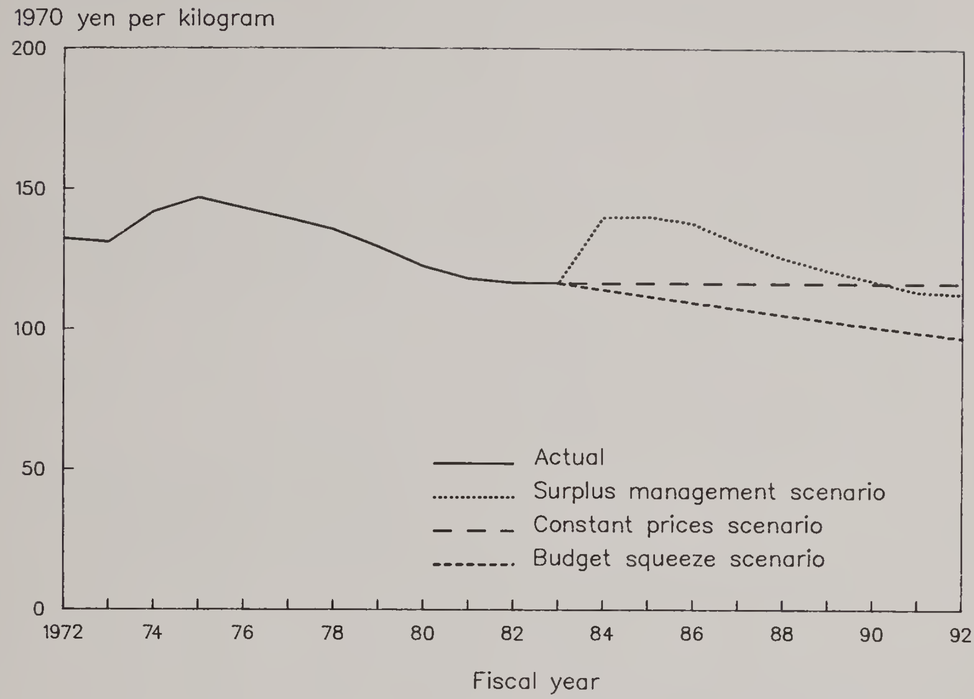
Fiscal year	Rice supply price			Wheat supply price			Barley supply price			Diversion payment		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze
	1970 yen per kilogram									Thousands of 1970 yen/hectare		
1984	140	116	114	77	71	70	70	64	63	152	193	189
1985	140	116	112	77	71	68	70	64	62	137	193	185
1986	138	116	110	77	71	67	70	64	60	155	193	181
1987	131	116	107	75	71	65	69	64	59	235	193	178
1988	126	116	105	74	71	64	68	64	58	345	193	174
1989	121	116	103	74	71	63	67	64	57	488	193	171
1990	117	116	101	73	71	62	66	64	56	659	193	167
1991	114	116	99	72	71	60	66	64	55	843	193	164
1992	113	116	97	72	71	59	65	64	54	901	193	161

Note: This table shows the fundamental differences between the three policy scenarios. Prices in the constant prices and budget squeeze scenarios are determined directly by assumption. Under the budget squeeze scenario, prices decline by 2 percent annually. The surplus management scenario involves a feedback mechanism in which past supply prices influence current production levels, and the past surplus of rice production over market demand influences current supply prices.

Source: Model projections and assumptions.

Figure 8.4

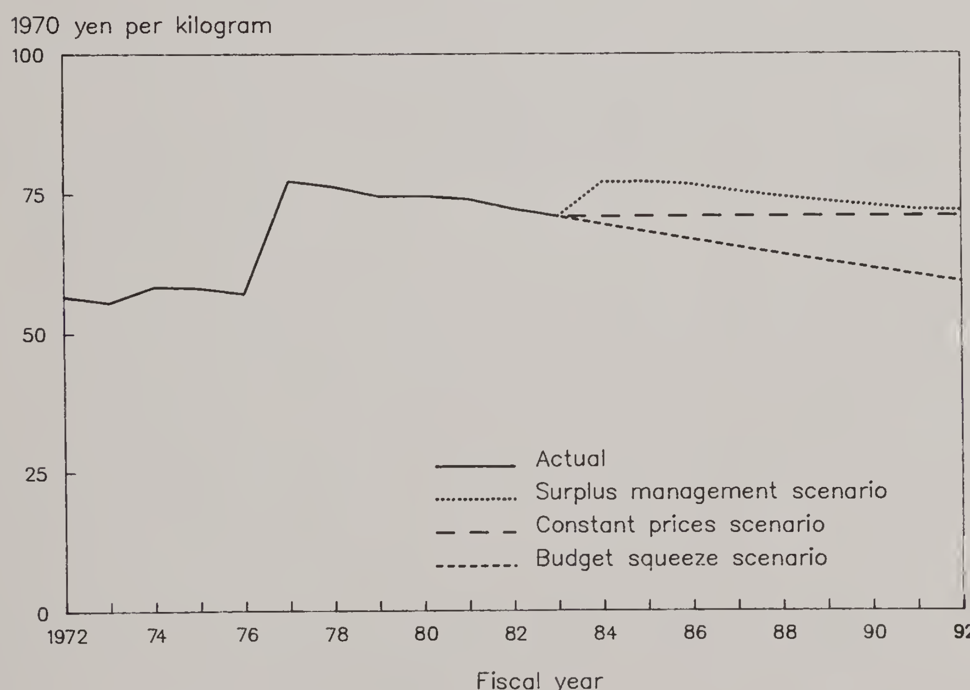
Actual and Projected Rice Supply Prices



Sources: Tables 2.15, 8.6, and 8.10.

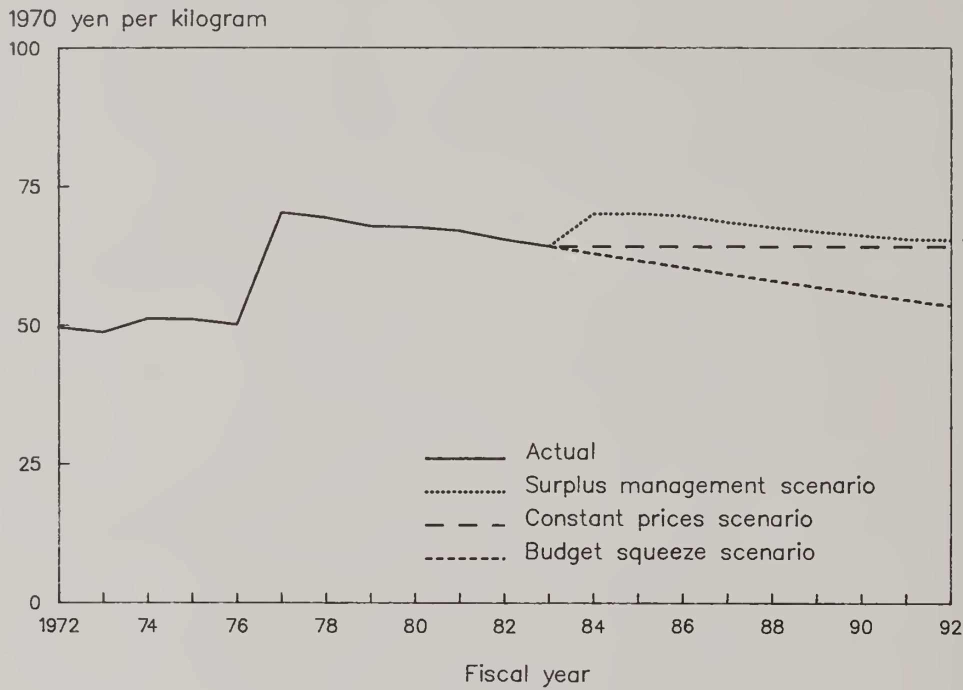
Figure 8.5

Actual and Projected Wheat Supply Prices



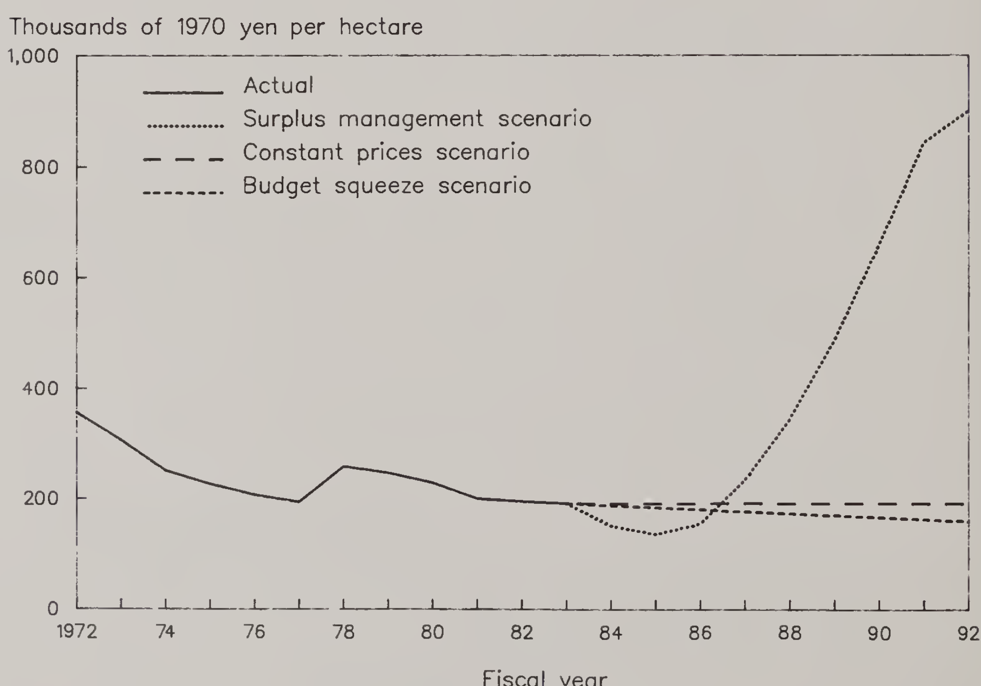
Sources: Tables 2.15, 8.6, and 8.10.

Figure 8.6
Actual and Projected Barley Supply Prices



Sources: Tables 2.15, 8.6, and 8.10.

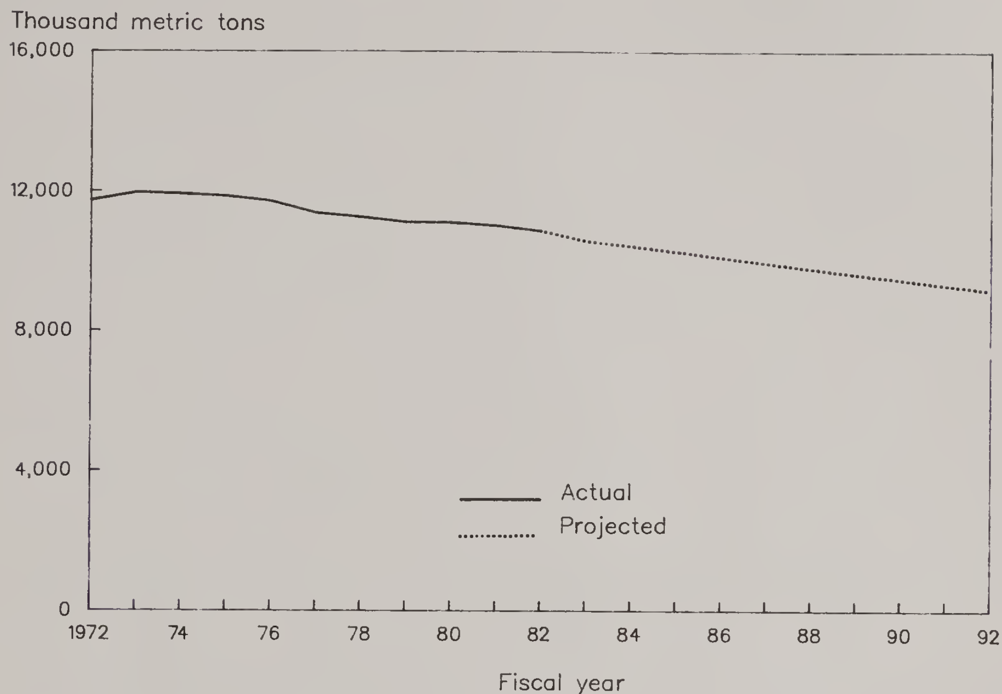
Figure 8.7
Actual and Projected Rice Diversion Payments



Sources: Tables 2.16, 8.6, and 8.10.

Figure 8.8

Actual and Projected Rice Used as Food



Sources: Tables 3.1, 8.1, and 8.11.

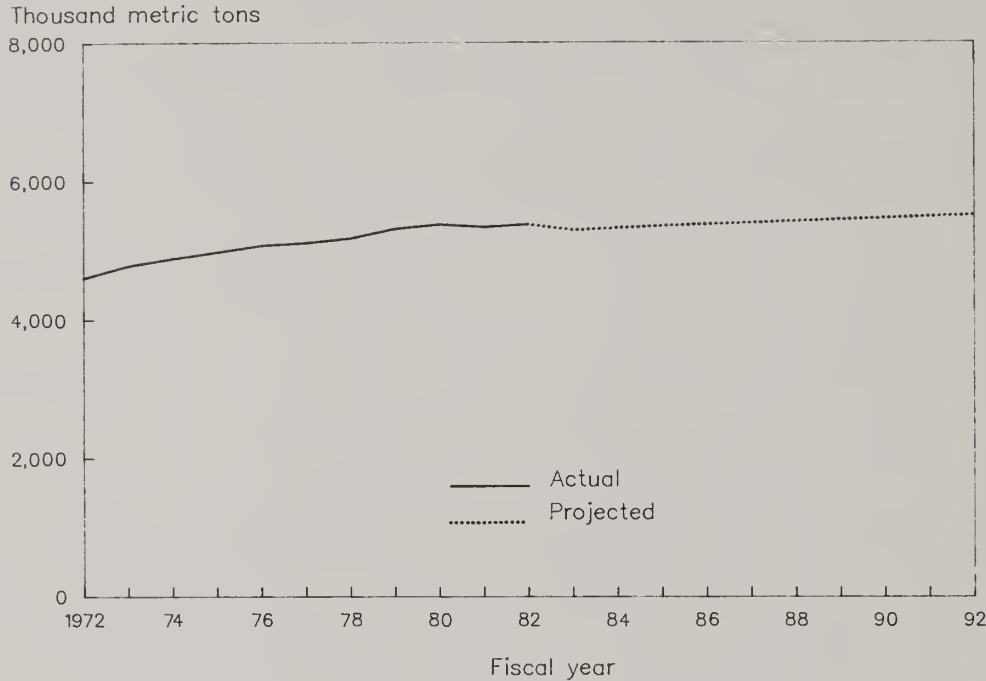
Table 8.11--Projected quantities of grain used as food

Fiscal year	Rice	Wheat	Barley, direct	Barley, indus'l	Barley, total	Corn	Other grain	Other coarse grains	Coarse grain
	Thousand metric tons								
1983	10,593	5,299	176	1,178	1,354	2,988	144	1,498	4,486
1984	10,439	5,329	154	1,253	1,407	3,246	150	1,557	4,803
1985	10,288	5,359	135	1,333	1,468	3,525	156	1,624	5,149
1986	10,123	5,382	117	1,415	1,532	3,823	163	1,695	5,518
1987	9,961	5,404	99	1,503	1,602	4,147	169	1,771	5,918
1988	9,801	5,427	84	1,596	1,680	4,497	176	1,856	6,353
1989	9,644	5,449	71	1,695	1,766	4,878	184	1,950	6,828
1990	9,489	5,472	60	1,800	1,860	5,290	191	2,051	7,341
1991	9,337	5,495	50	1,911	1,961	5,737	199	2,160	7,897
1992	9,187	5,517	41	2,030	2,071	6,222	207	2,278	8,500

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

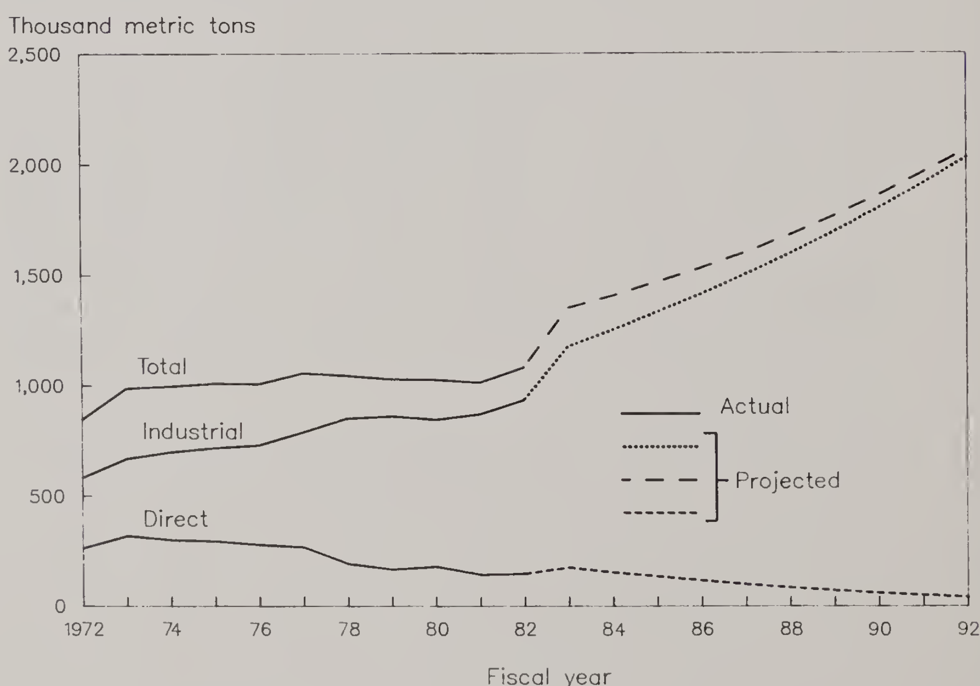
Source: Model projections.

Figure 8.9
Actual and Projected Wheat Used as Food



Sources: Tables 3.1, 8.1, and 8.11.

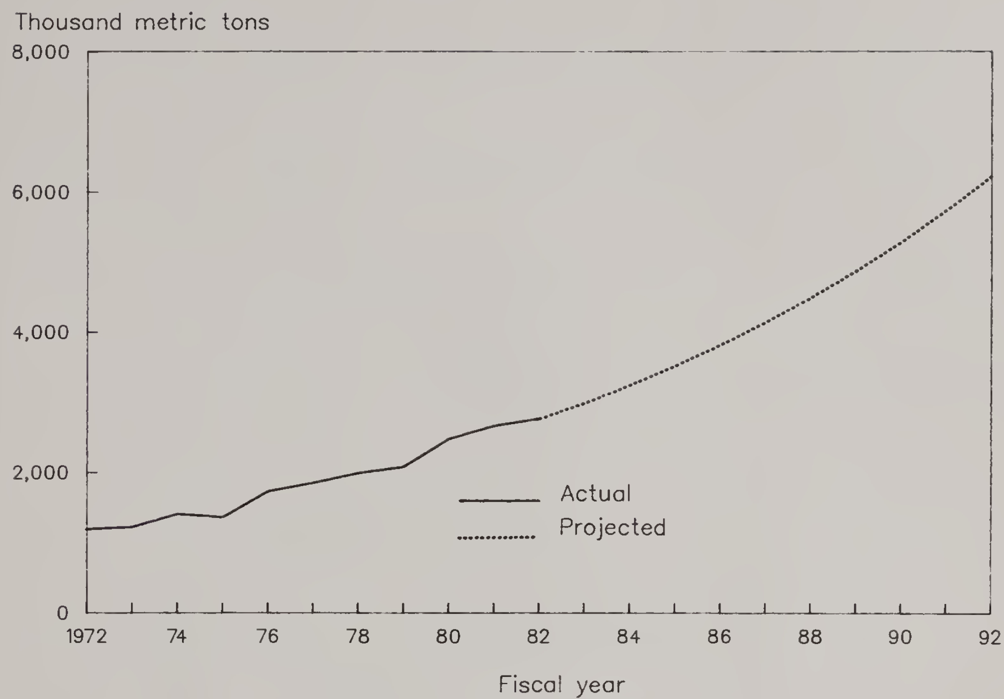
Figure 8.10
Actual and Projected Barley Used as Food



Sources: Tables 3.5, 8.1, and 8.11.

Figure 8.11

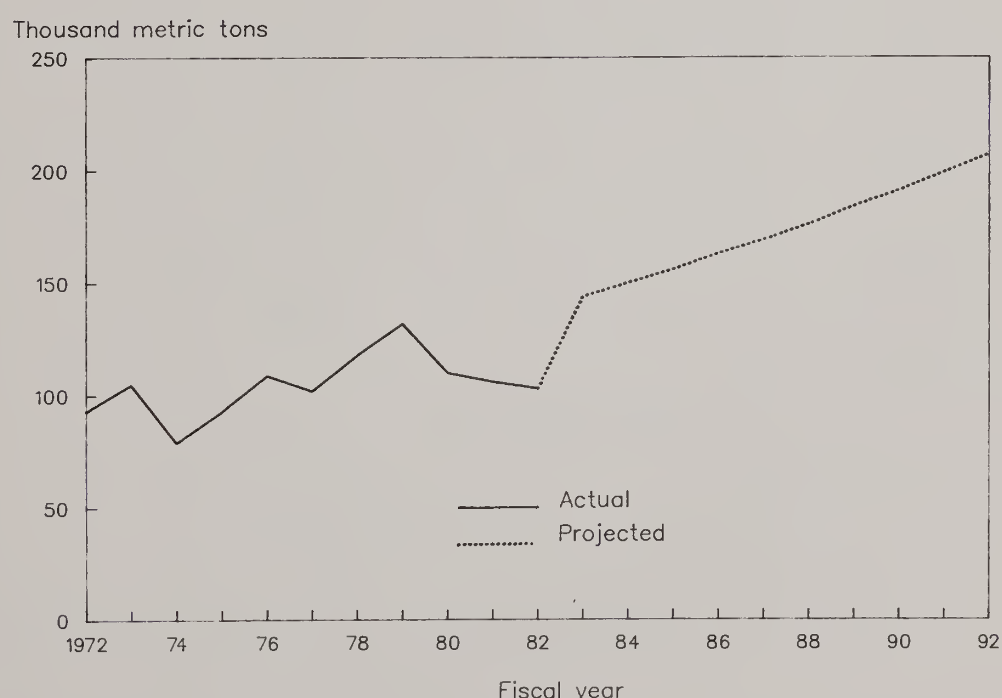
Actual and Projected Corn Used as Food



Sources: Tables 3.1, 8.1, and 8.11.

Figure 8.12

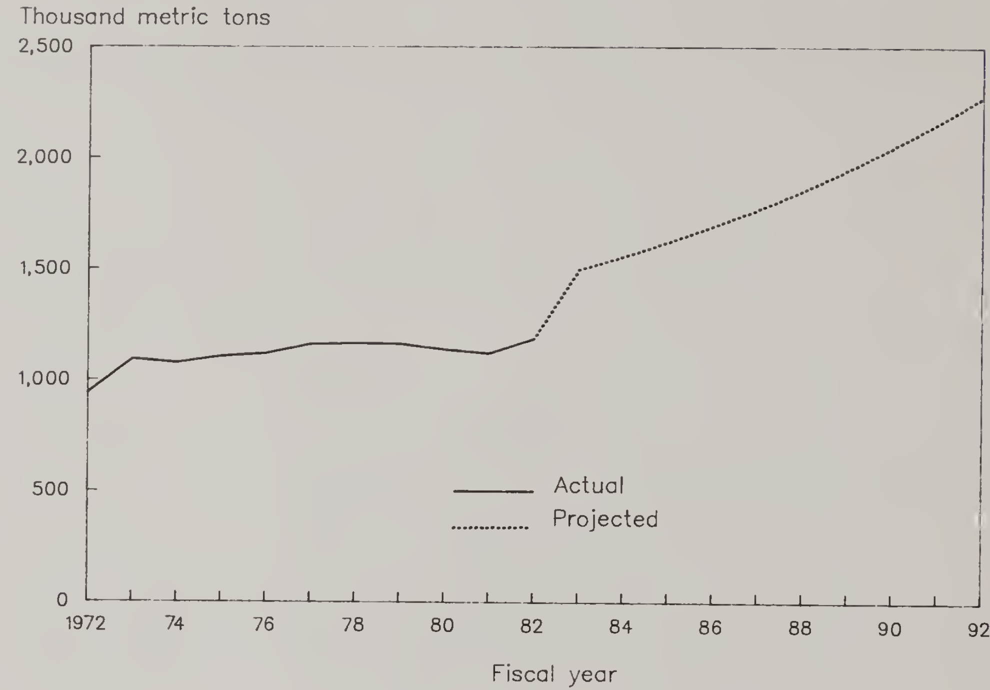
Actual and Projected Other Grain Used as Food



Sources: Tables 3.1, 8.1, and 8.11.

Figure 8.13

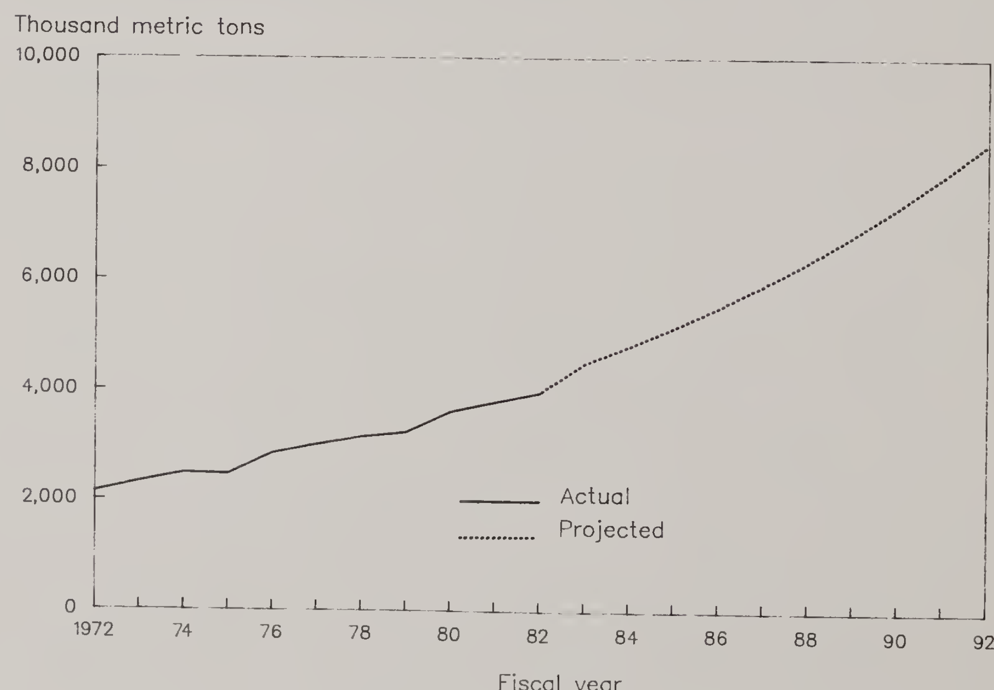
Actual and Projected Other Coarse Grains Used as Food



Sources: Calculated as sum of barley and other grain statistics in Tables 3.1, 8.1, and 8.11.

Figure 8.14

Actual and Projected Coarse Grain Used as Food



Sources: Calculated as sum of barley, corn, and other grain statistics in Tables 3.1, 8.1, and 8.11.

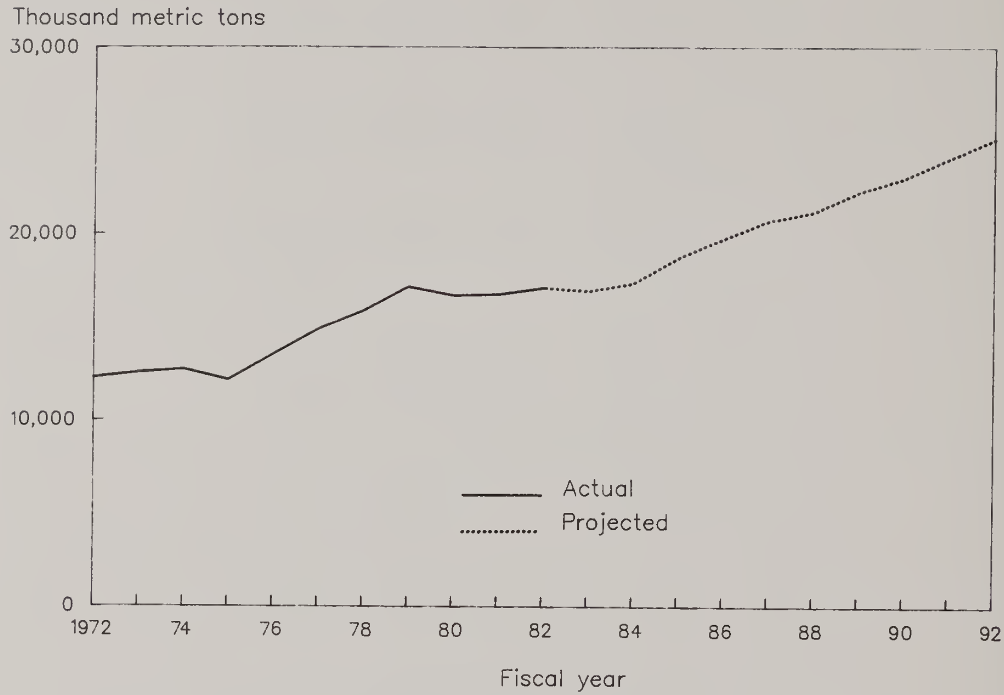
Table 8.12--Projected quantities of grain used as feed

Fiscal year	Total grain used as feed	Wheat used as feed	Non-wheat grain feed	Rice used as feed			Corn used as feed			Other coarse grain feed			Coarse grain feed		
				Surplus manage-ment	Con-stant prices	Budget squeeze	Surplus manage-ment	Con-stant prices	Budget squeeze	Surplus manage-ment	Con-stant prices	Budget squeeze	Surplus manage-ment	Con-stant prices	Budget squeeze
	Thousand metric tons														
1983	16,929	508	16,421	36	36	36	9,025	9,025	9,025	7,360	7,360	7,360	16,385	16,385	16,385
1984	17,346	491	16,855	14	14	14	9,024	9,024	9,024	7,817	7,817	7,817	16,841	16,841	16,841
1985	18,722	498	18,224	8	8	8	10,083	10,083	10,083	8,133	8,133	8,133	18,216	18,216	18,216
1986	19,754	495	19,259	16	7	7	10,762	10,767	10,767	8,481	8,485	8,485	19,243	19,252	19,252
1987	20,718	489	20,229	36	36	31	11,172	11,172	11,175	9,021	9,021	9,023	20,193	20,193	20,198
1988	21,189	471	20,718	1,348	50	36	10,784	11,507	11,514	8,586	9,161	9,168	19,370	20,668	20,682
1989	22,268	465	21,803	2,844	550	106	10,611	11,895	12,143	8,348	9,358	9,554	18,959	21,253	21,697
1990	23,012	453	22,559	3,798	2,246	1,387	10,603	11,480	11,965	8,158	8,833	9,207	18,761	20,313	21,172
1991	24,073	446	23,627	4,580	2,992	2,316	10,921	11,832	12,220	8,126	8,803	9,091	19,047	20,635	21,311
1992	25,107	437	24,670	4,790	3,658	2,812	11,313	11,957	12,438	8,567	9,055	9,420	19,880	21,012	21,858

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

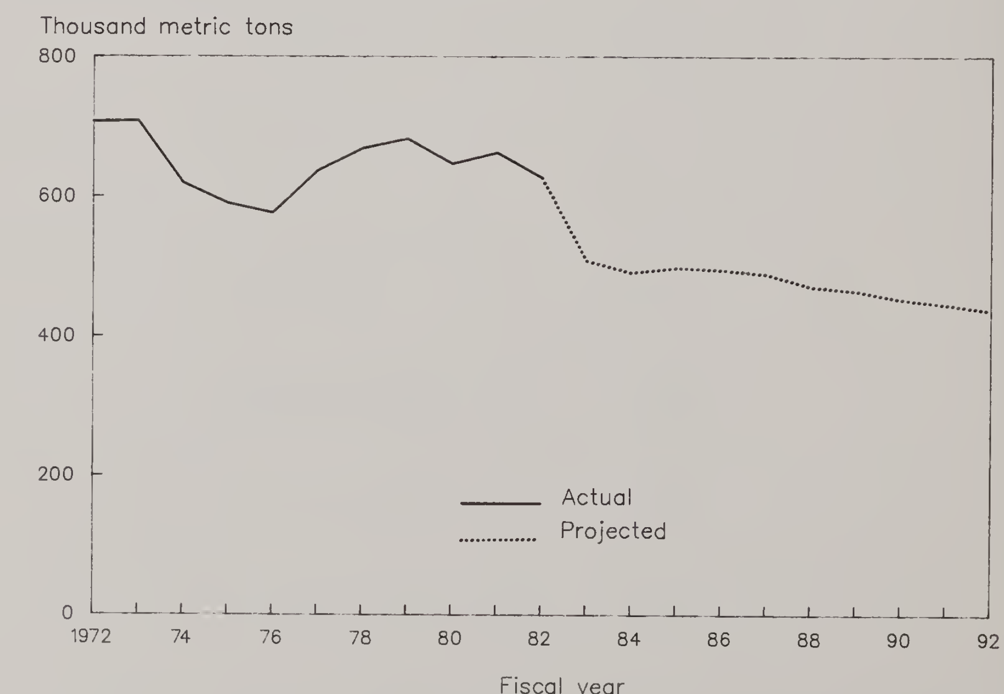
Source: Model projections.

Figure 8.15
Actual and Projected Grain Used as Feed



Sources: Tables 4.1, 8.1, and 8.12.

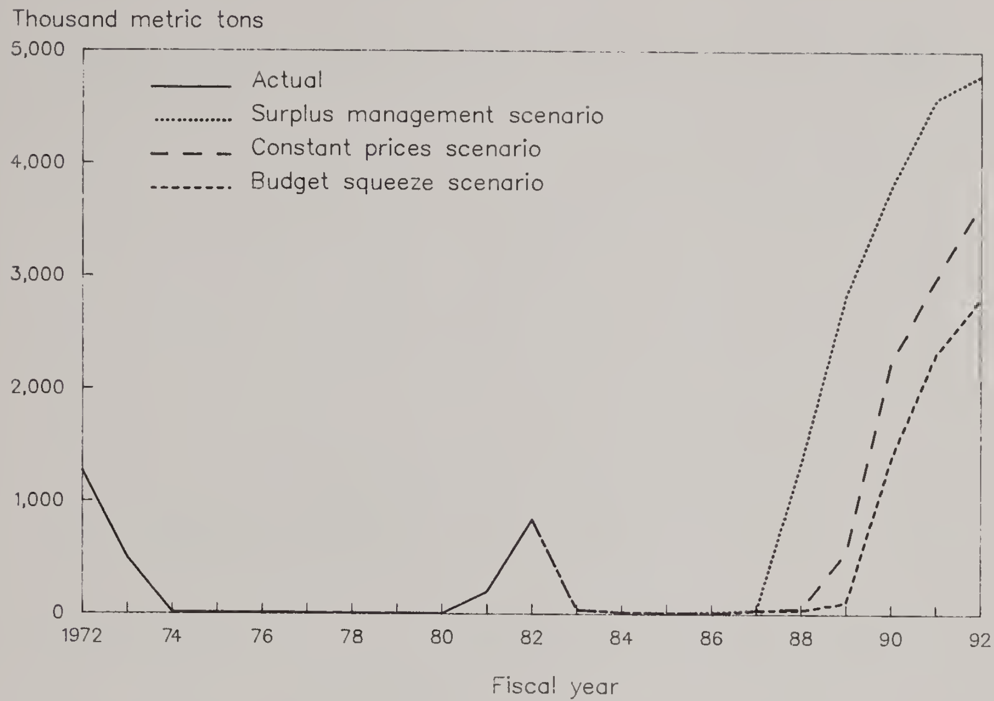
Figure 8.16
Actual and Projected Wheat Used as Feed



Sources: Tables 4.1, 8.1, and 8.12.

Figure 8.17

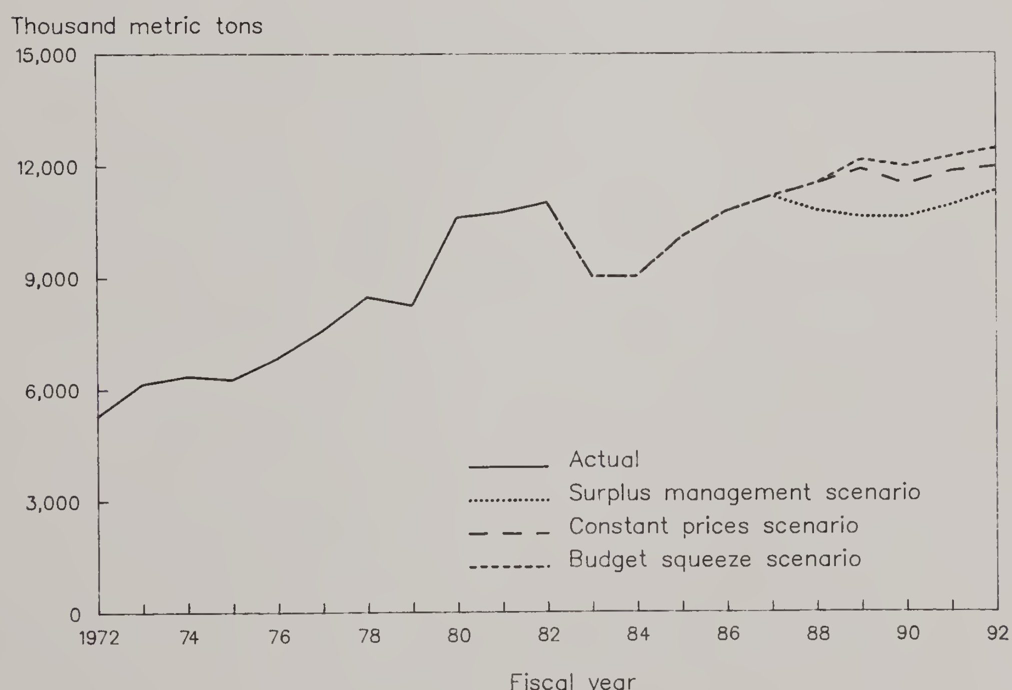
Actual and Projected Rice Used as Feed



Sources: Tables 4.1, 8.1, and 8.12.

Figure 8.18

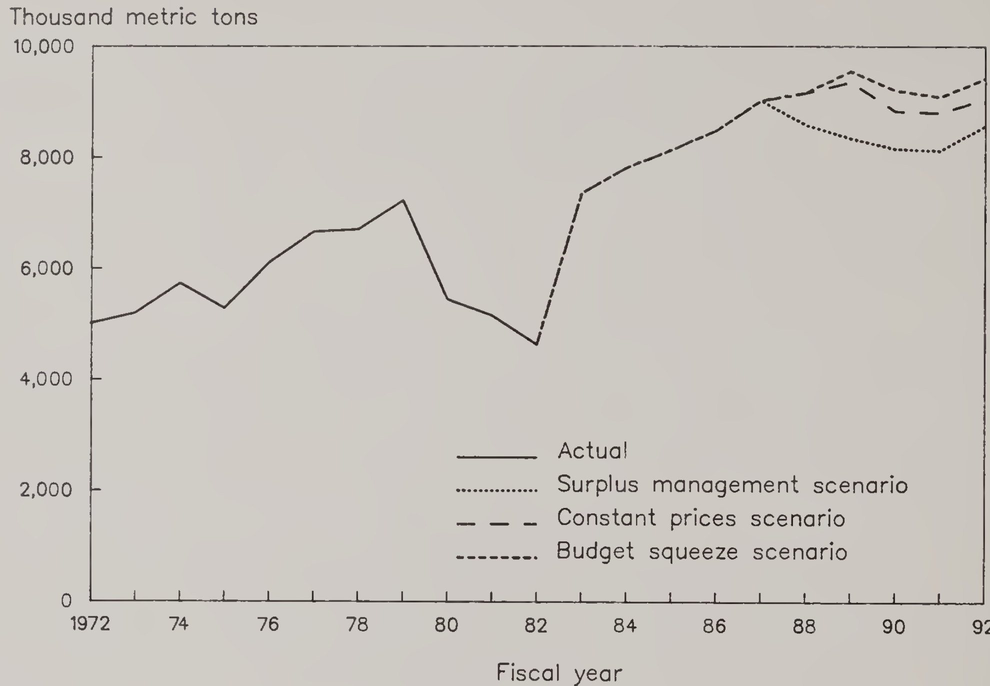
Actual and Projected Corn Used as Feed



Sources: Tables 4.1, 8.1, and 8.12.

Figure 8.19

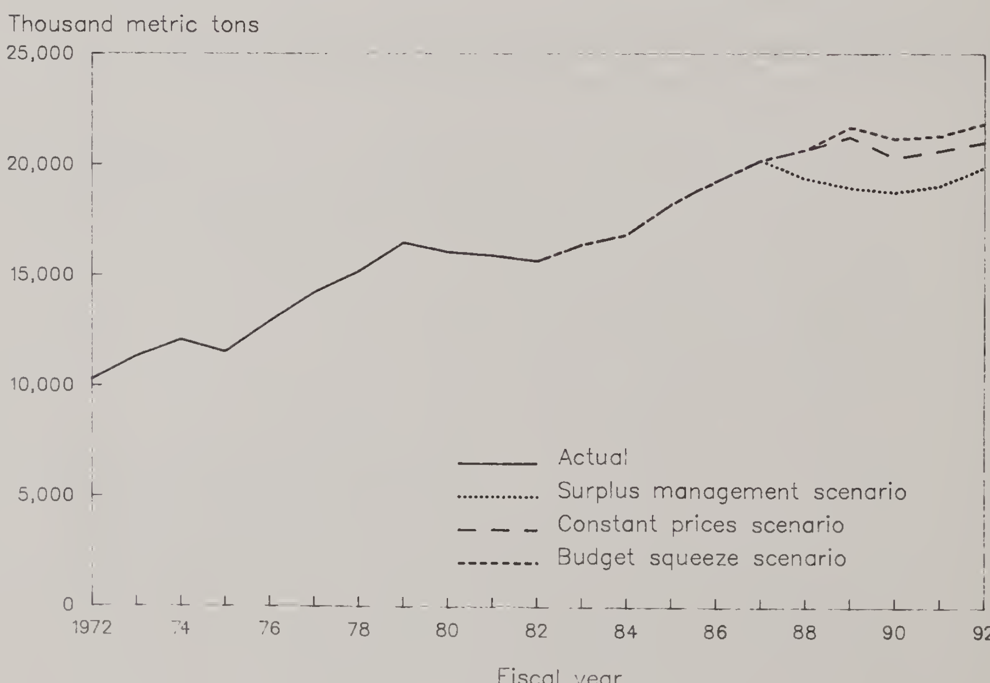
Actual and Projected Other Coarse Grains Used as Feed



Sources: Calculated as sum of barley and other grain statistics in Tables 4.1, 8.1, and 8.12.

Figure 8.20

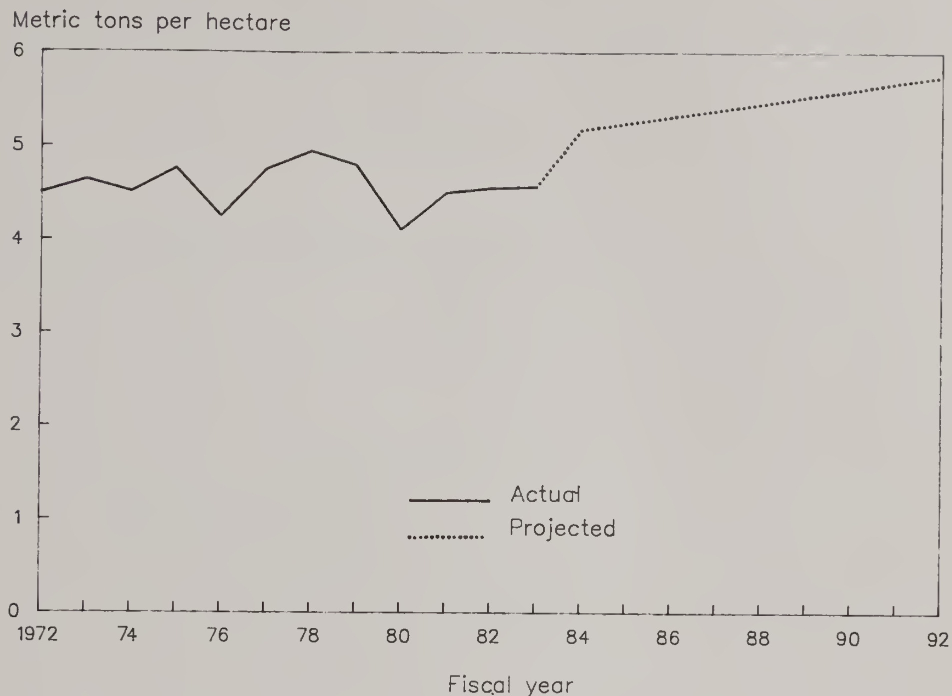
Actual and Projected Coarse Grain Used as Feed



Sources: Calculated as sum of barley, corn, and other grain statistics in Tables 4.1, 8.1, and 8.12.

Figure 8.21

Actual and Projected Rice Yield



Sources: Tables 2.7, 8.7, and 8.13.

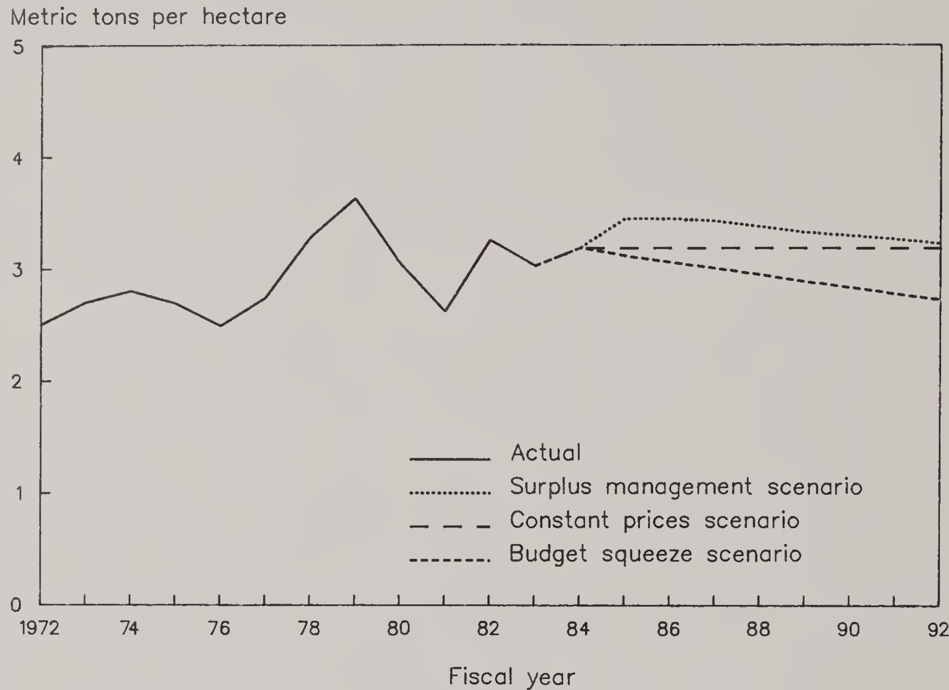
Table 8.13--Projected grain yields

Fiscal year	Rice yield	Wheat yield: Surplus management	Wheat yield: Constant prices	Wheat yield: Budget squeeze	Barley yield: Surplus management	Barley yield: Constant prices	Barley yield: Budget squeeze
	Metric tons per hectare						
1984	5.17	3.19	3.19	3.19	3.28	3.28	3.28
1985	5.24	3.45	3.19	3.12	3.47	3.28	3.24
1986	5.31	3.45	3.19	3.06	3.47	3.28	3.20
1987	5.38	3.43	3.19	3.01	3.46	3.28	3.16
1988	5.45	3.38	3.19	2.95	3.42	3.28	3.12
1989	5.53	3.33	3.19	2.89	3.39	3.28	3.08
1990	5.60	3.30	3.19	2.84	3.37	3.28	3.04
1991	5.68	3.27	3.19	2.78	3.35	3.28	3.00
1992	5.75	3.23	3.19	2.73	3.32	3.28	2.96

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

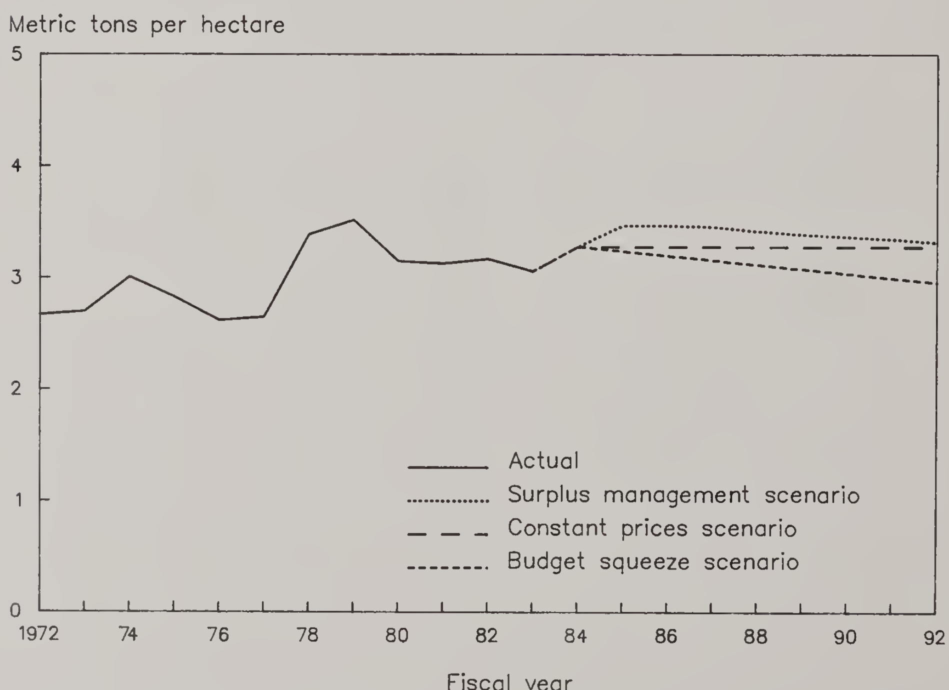
Source: Model projections.

Figure 8.22
Actual and Projected Wheat Yield



Sources: Tables 2.7, 8.7, and 8.13.

Figure 8.23
Actual and Projected Barley Yield



Sources: Tables 2.7, 8.7, and 8.13.

Table 8.14--Projected expected revenues from grains

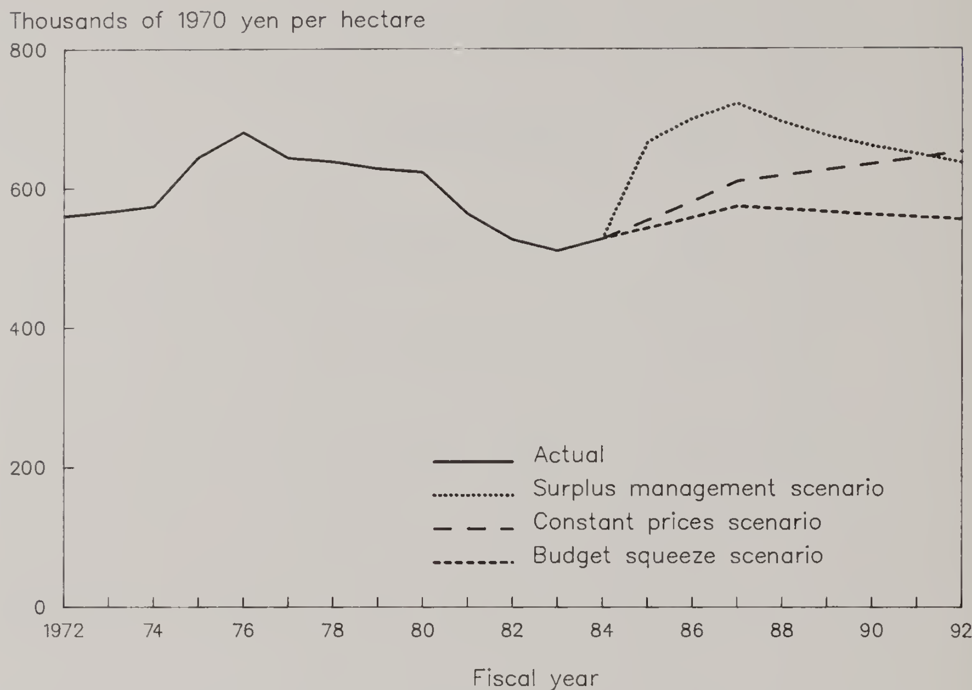
Fiscal year	Expected revenue from rice			Expected revenue from wheat			Expected revenue from barley			Average expected revenue from wheat and barley			Average expected revenue from three grains		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze
	Thousands of 1970 yen per hectare														
1985	666	554	543	244	224	220	222	204	200	233	214	210	627	524	513
1986	700	581	558	249	223	212	229	206	197	240	215	205	662	550	529
1987	721	610	574	258	226	209	238	211	196	248	219	203	685	580	547
1988	695	618	570	260	226	201	238	211	190	250	219	195	662	591	546
1989	675	626	566	255	226	193	233	211	183	245	219	188	645	601	545
1990	661	635	562	249	226	186	229	211	178	240	219	182	634	611	544
1991	649	643	558	243	226	178	225	211	172	235	219	175	625	622	543
1992	636	652	555	238	226	171	221	211	166	230	219	169	615	632	541

Note: Expected revenue is defined as the previous year's supply price times the average of the previous 3 years' yields.

Source: Model projections.

Figure 8.24

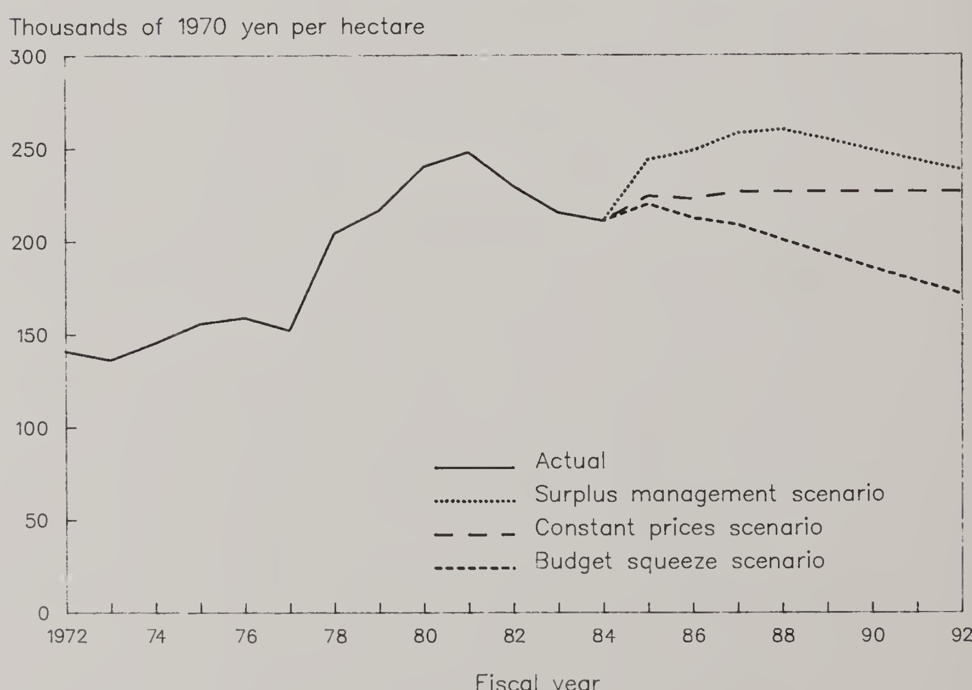
Actual and Projected Expected Revenue from Rice



Sources: Tables 5.5, 8.8, and 8.14.

Figure 8.25

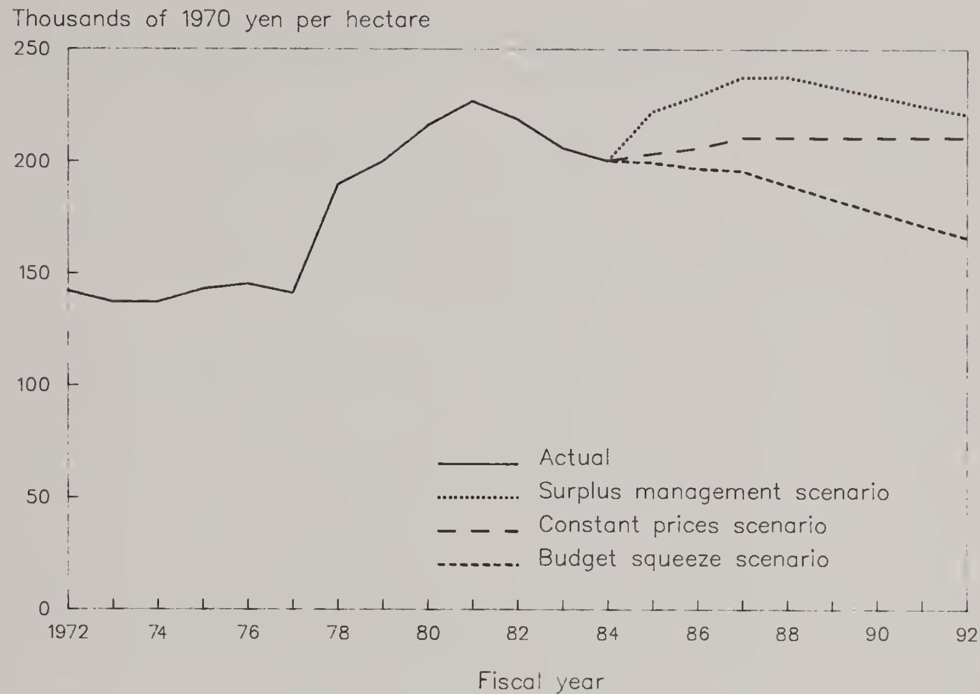
Actual and Projected Expected Revenue from Wheat



Sources: Tables 5.6, 8.8, and 8.14.

Figure 8.26

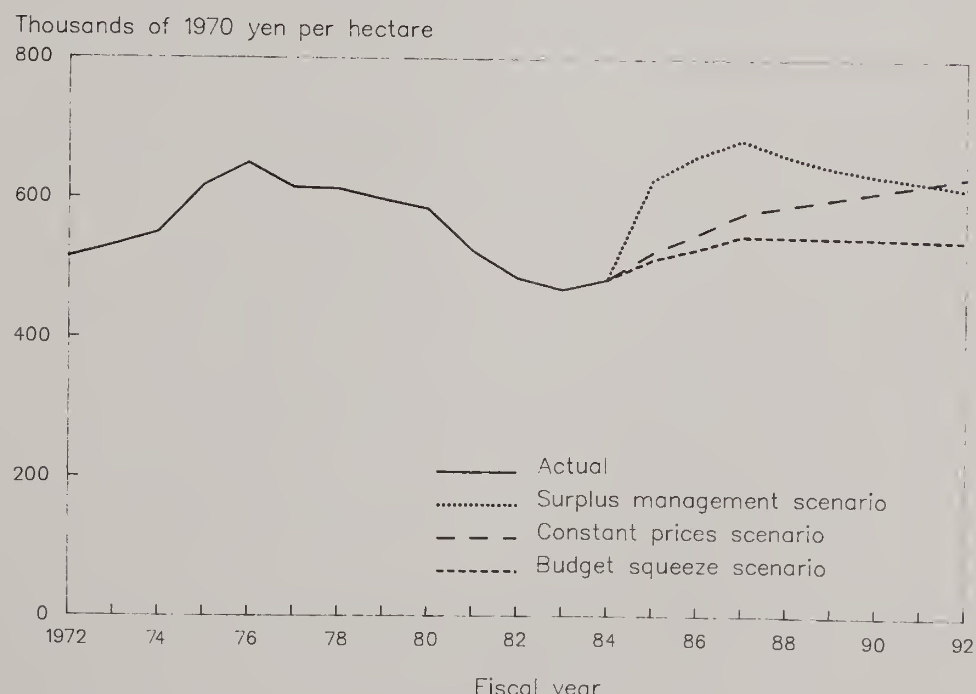
Actual and Projected Expected Revenue from Barley



Sources: Tables 5.7, 8.8, and 8.14.

Figure 8.27

Actual and Projected Average Expected Revenue from Grains



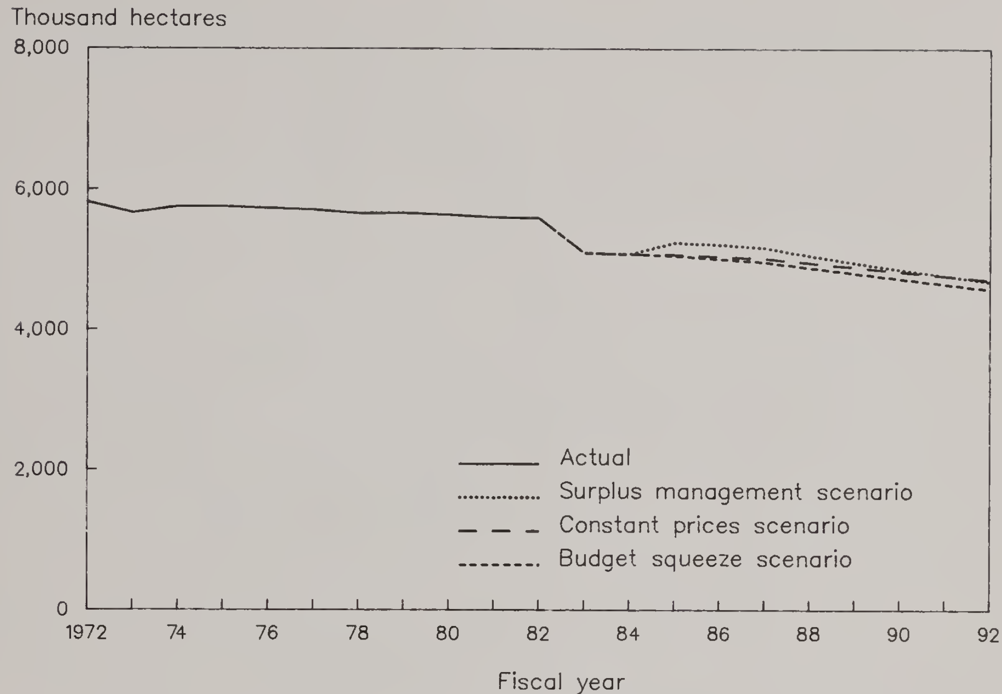
Sources: Tables 5.9, 8.8, and 8.14.

Table 8.15--Projected crop areas

Fiscal year	Total area planted			Rice area planted			Wheat area planted			Barley area planted			Other nonrice area planted		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze
	Thousand hectares														
1984	5,077	5,077	5,077	2,074	2,074	2,074	105.1	105.1	105.1	99.1	99.1	99.1	2,799	2,799	2,799
1985	5,240	5,070	5,052	2,356	2,110	2,089	113.9	104.8	102.0	98.0	89.1	86.8	2,672	2,766	2,774
1986	5,215	5,043	5,006	2,390	2,149	2,108	105.4	92.8	86.9	92.9	82.4	77.7	2,627	2,719	2,733
1987	5,170	5,016	4,963	2,389	2,184	2,127	100.0	84.9	75.6	87.8	76.2	69.3	2,593	2,671	2,691
1988	5,058	4,954	4,884	2,293	2,172	2,100	91.8	75.9	63.7	79.5	68.2	59.3	2,594	2,638	2,661
1989	4,955	4,892	4,806	2,223	2,158	2,074	80.4	67.9	53.7	69.9	61.0	50.7	2,582	2,605	2,628
1990	4,862	4,830	4,729	2,166	2,146	2,048	69.8	60.6	45.2	61.3	54.5	43.3	2,565	2,569	2,593
1991	4,774	4,769	4,653	2,116	2,133	2,022	60.5	54.2	38.0	53.7	48.6	36.9	2,544	2,533	2,556
1992	4,686	4,710	4,578	2,065	2,121	1,997	52.5	48.4	31.9	47.0	43.4	31.4	2,522	2,497	2,518

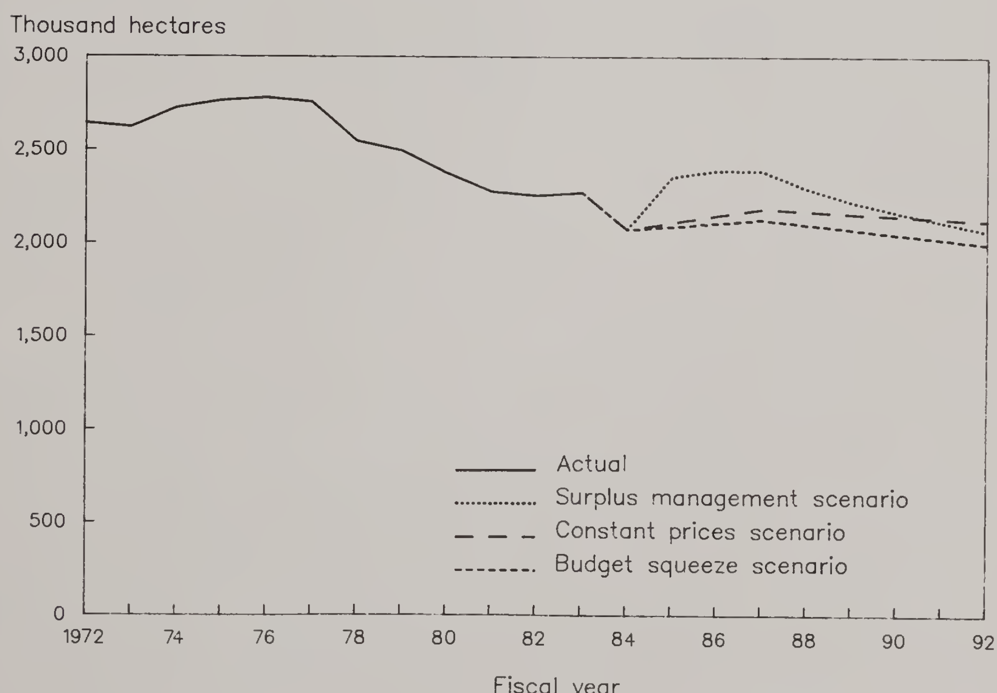
Source: Model projections.

Figure 8.28
Actual and Projected Total Area Planted



Sources: Gross total area planted from Tables 2.7, 8.7, and 8.15.

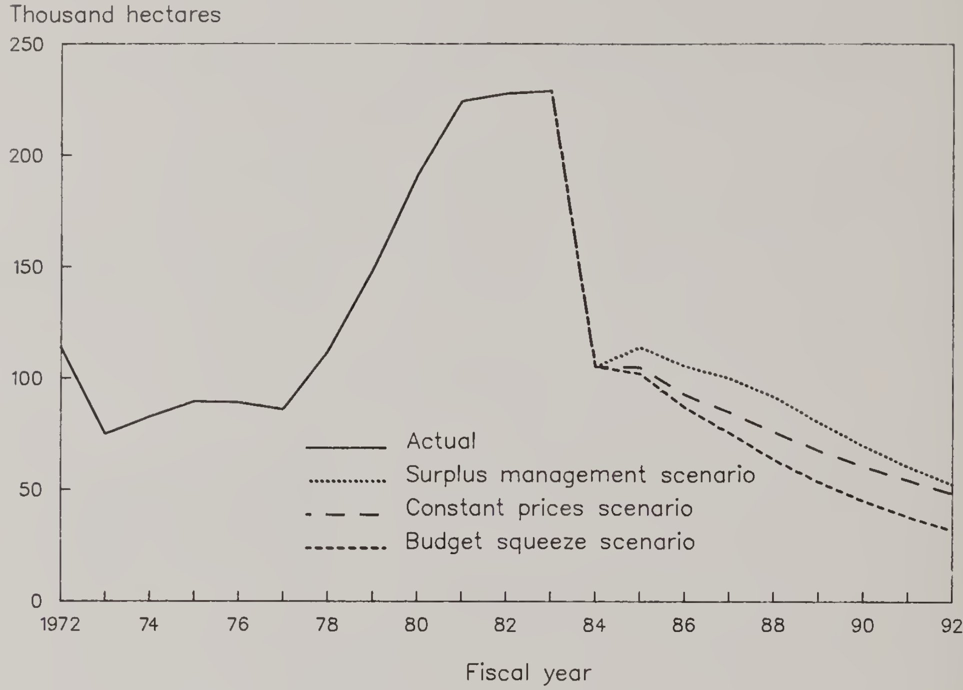
Figure 8.29
Actual and Projected Rice Area



Sources: Tables 2.7, 8.7 and 8.15.

Figure 8.30

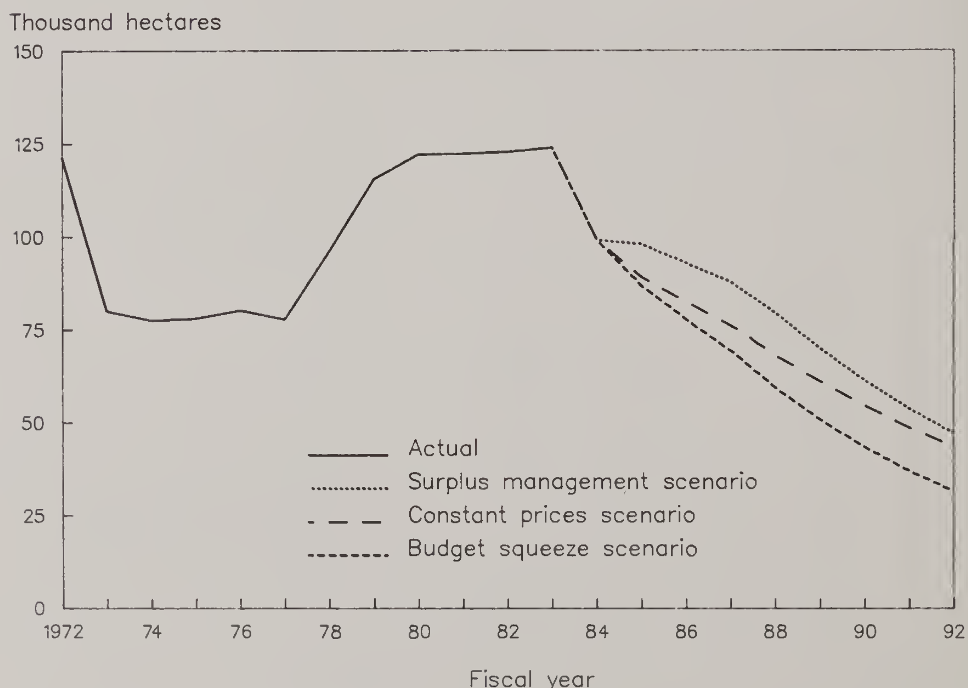
Actual and Projected Wheat Area



Sources: Tables 2.7, 8.7, and 8.15.

Figure 8.31

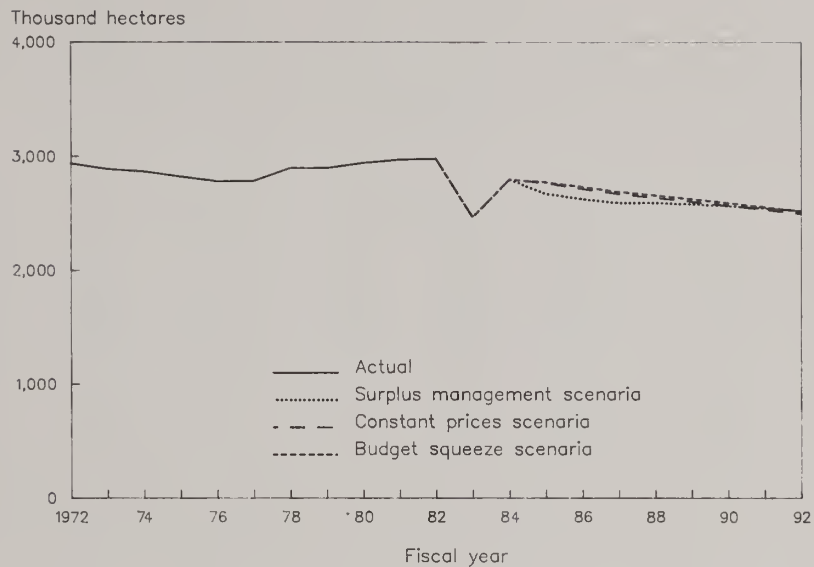
Actual and Projected Barley Area



Sources: Tables 2.7, 8.7, and 8.15.

Figure 8.32

Actual and Projected Other Nonrice Area



Sources: Tables 2.7 (subtracting rice, wheat, and barley areas from gross total area), Table 8.7, and Table 8.15.

Areas and Production

The model projects that the gross total area planted will diminish from 5.6 million hectares in 1982 to 4.6 or 4.7 million hectares in 1992 (Tables 8.7 and 8.15). Figure 8.28 indicates that the projected diminution may be overstated--perhaps 5 million hectares in 1992 would be a more reasonable estimate. The rice area is projected to decline by only 6 to 12 percent between 1982 and 1992, from 2.3 million hectares to 2.0 or 2.1 million hectares. Such changes would be consistent with long-run patterns of past behavior (as shown in Figure 8.29). The model's projections for wheat and barley areas (Figures 8.30 and 8.31) appear clearly too low.

Production is calculated as area times yield. Yields are projected to grow in fairly straight lines (Figures 8.21 to 8.23). Seed usage is calculated as a constant fraction of production. In consequence, the patterns of projected rice, wheat, and barley areas are transformed with little distortion into patterns of projected production net of seed.

The rise in projected rice yields more than offsets the fall in projected rice areas, so that rice production net of seed is expected to increase from 10 million metric tons in 1982 to 11 or 12 million metric tons in 1992 (Tables 8.1 and 8.18, and Figure 8.33). The model projects drastic drops in wheat and barley net production. These are probably exaggerated, as can be seen from Figures 8.34 and 8.35. However, even major errors in projecting wheat and barley supplies would cause quite small errors in projecting net imports of wheat and net imports of other coarse grains, because domestic supplies of these grains are only a small fraction of the domestic demand for food and feed. The model also projects that net production of corn will cease entirely, and that net production of "other grain" will almost cease (Figures 8.36 and 8.37). 5/

--Text continues to page 335.

Table 8.16--Projected grain production

Fiscal year	Rice supply: Surplus management	Rice supply: Constant prices	Rice supply: Budget squeeze	Wheat supply: Surplus management	Wheat supply: Constant prices	Wheat supply: Budget squeeze	Barley supply: Surplus management	Barley supply: Constant prices	Barley supply: Budget squeeze
	Thousand metric tons								
1984	10,723	10,723	10,723	335	335	335	325	325	325
1985	12,345	11,056	10,946	393	334	318	340	292	281
1986	12,691	11,411	11,193	364	296	266	322	270	249
1987	12,853	11,750	11,443	343	271	228	304	250	219
1988	12,497	11,837	11,445	310	242	188	272	224	185
1989	12,293	11,934	11,469	268	217	155	237	200	156
1990	12,130	12,018	11,469	230	193	128	207	179	132
1991	12,019	12,115	11,485	198	173	106	180	159	111
1992	11,874	12,196	11,483	170	154	87	156	142	93

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Source: Model projections.

Table 8.17--Projected quantities of grain used as seed

Fiscal year	Rice used as seed: Surplus management	Rice used as seed: Constant prices	Rice used as seed: Budget squeeze	Wheat used as seed: Surplus management	Wheat used as seed: Constant prices	Wheat used as seed: Budget squeeze	Barley used as seed: Surplus management	Barley used as seed: Constant prices	Barley used as seed: Budget squeeze
	Thousand metric tons								
1983	78	78	78	28	28	28	9	9	9
1984	80	80	80	13	13	13	8	8	8
1985	93	83	82	16	13	13	9	7	7
1986	95	86	84	15	12	11	8	7	6
1987	96	88	86	14	11	9	8	6	5
1988	94	89	86	12	10	8	7	6	5
1989	92	90	86	11	9	6	6	5	4
1990	91	90	86	9	8	5	5	4	3
1991	90	91	86	8	7	4	5	4	3
1992	89	91	86	7	6	3	4	4	2

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Source: Model projections.

Table 8.18--Projected grain production net of seed used

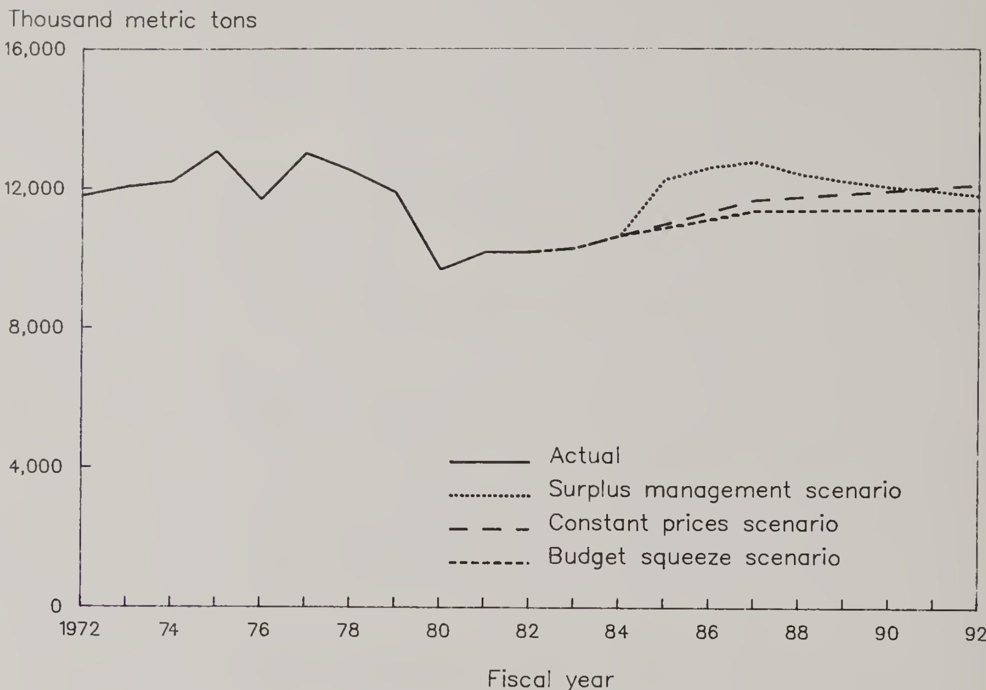
Fiscal year	Rice net production			Wheat net production			Barley net production			Corn net production	Other grain net production	Other coarse grains net production		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze			Surplus management	Constant prices	Budget squeeze
	Thousand metric tons													
1983	10,288	10,288	10,288	667	667	667	370	370	370	2	21	391	391	391
1984	10,643	10,643	10,643	322	322	322	317	317	317	1	19	336	336	336
1985	12,252	10,973	10,864	377	321	305	331	285	274	1	17	348	302	291
1986	12,596	11,325	11,109	349	284	255	314	263	243	1	15	329	278	258
1987	12,757	11,662	11,357	329	260	219	296	244	214	1	13	309	257	227
1988	12,403	11,748	11,359	298	232	180	265	218	180	0	12	277	230	192
1989	12,201	11,844	11,383	257	208	149	231	195	152	0	11	242	206	163
1990	12,039	11,928	11,383	221	185	123	202	175	129	0	9	211	184	138
1991	11,929	12,024	11,399	190	166	102	175	155	108	0	8	183	163	116
1992	11,785	12,105	11,397	163	148	84	152	138	91	0	8	160	146	99

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Source: Model projections.

Figure 8.33

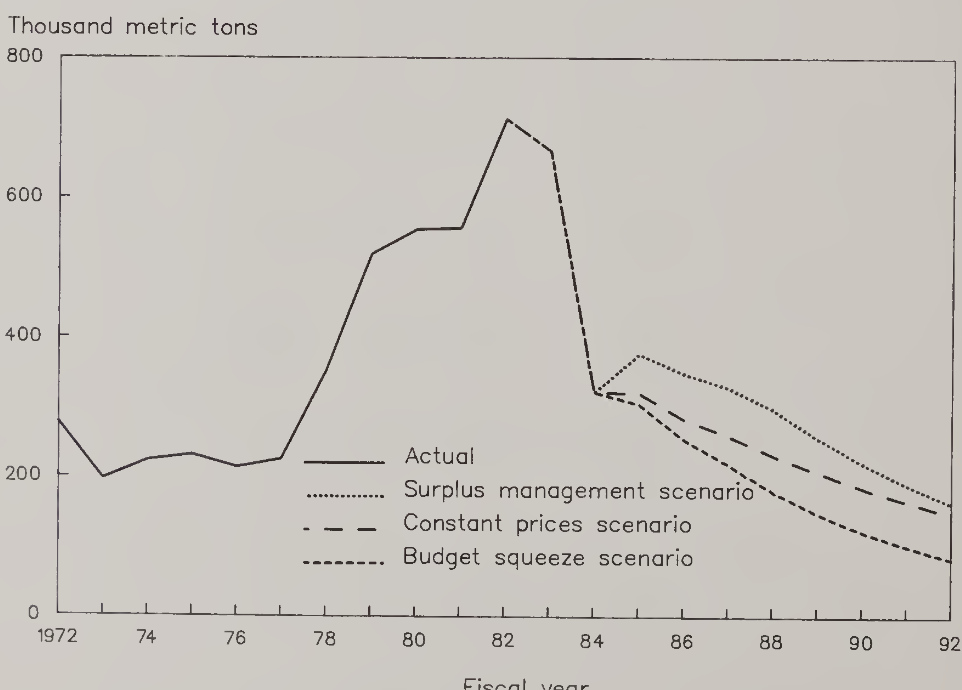
Actual and Projected Rice Production Net of Seed Used



Sources: Derived from Tables 5.1, 8.1 and 8.18.

Figure 8.34

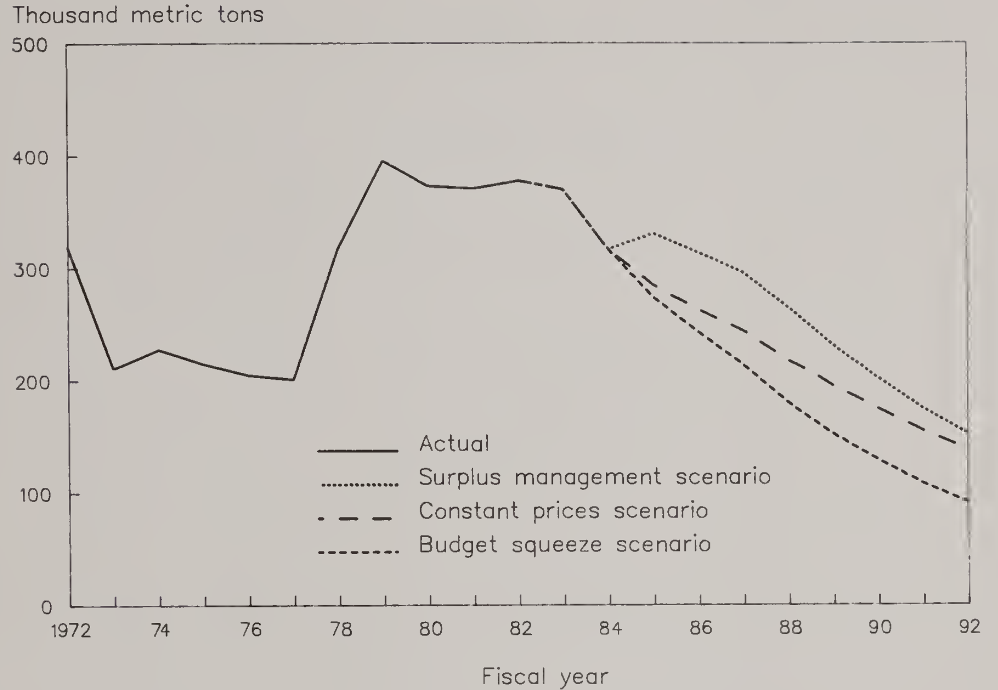
Actual and Projected Wheat Production Net of Seed Used



Sources: Derived from Tables 5.1, 8.1, and 8.18.

Figure 8.35

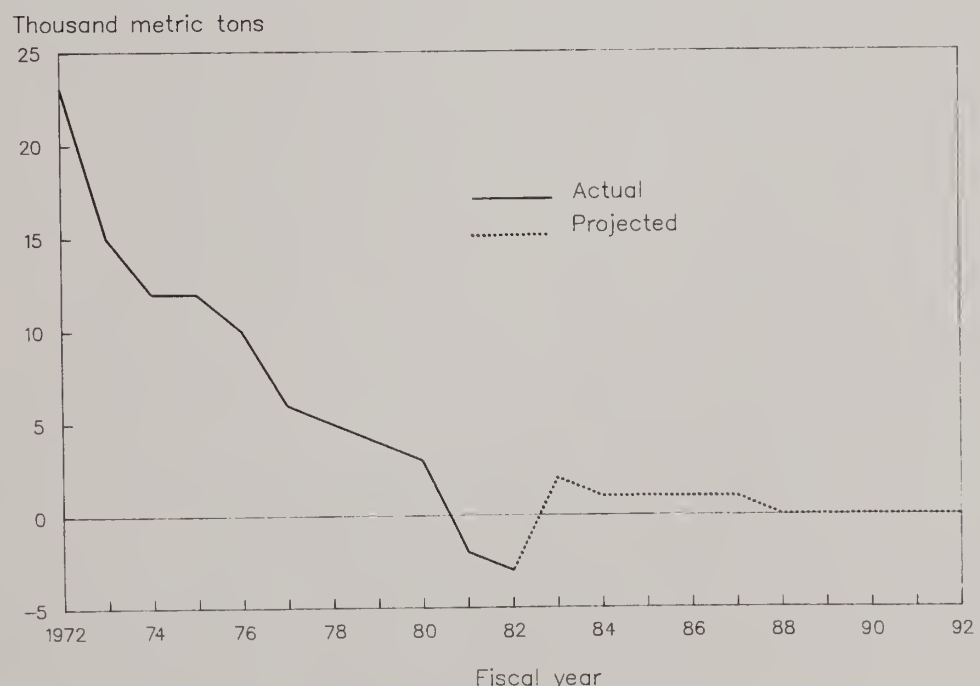
Actual and Projected Barley Production Net of Seed Used



Sources: Derived from Tables 5.1, 8.1, and 8.18.

Figure 8.36

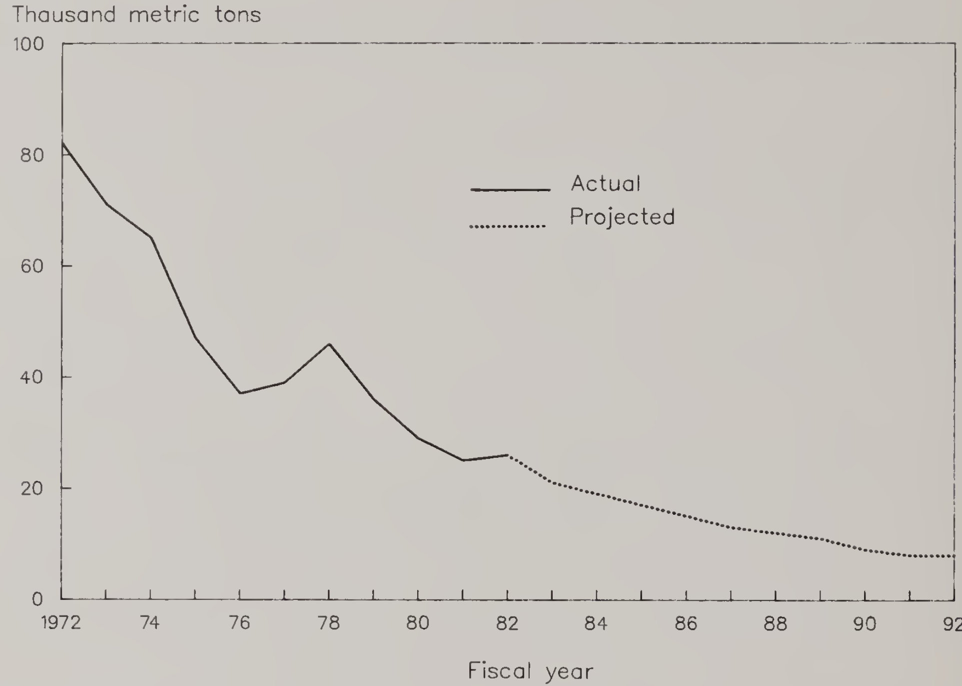
Actual and Projected Corn Production Net of Seed Used



Sources: Derived from Tables 5.1, 8.1, and 8.18.

Figure 8.37

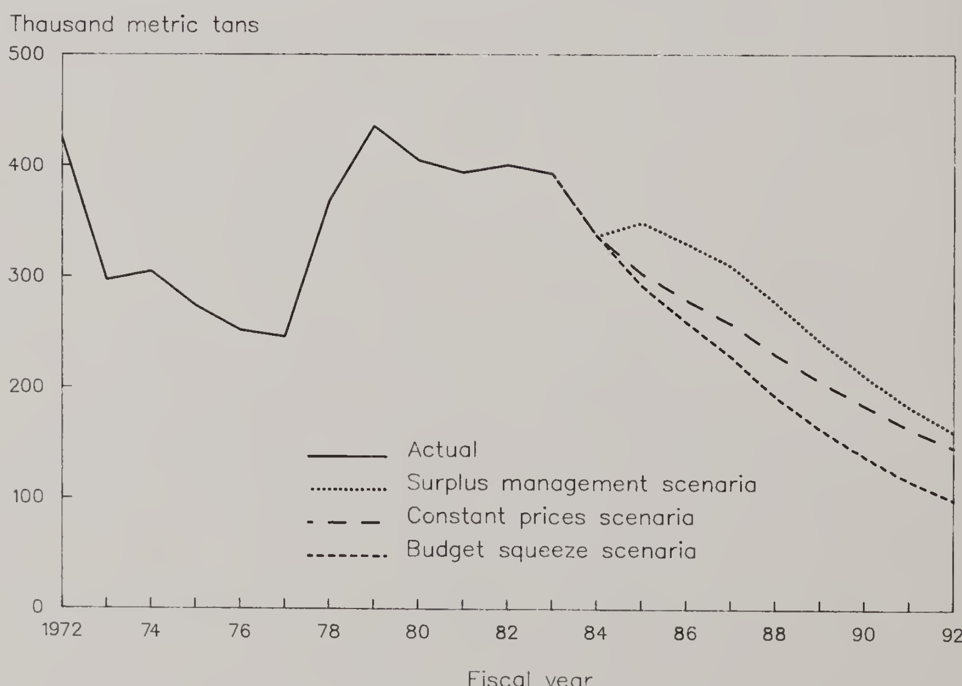
Actual and Projected Other Grain Production Net of Seed Used



Sources: Derived from Tables 5.1, 8.1, and 8.18

Figure 8.38

Actual and Projected Coarse Grain Production Net of Seed Used



Sources: Calculated as sum of corn, barley, and other grain statistics in Tables 5.1, 8.1, and 8.18.

Table 8.19--Projected measures of Japan's rice surplus and its disposal

Fiscal year	Excess rice production			Average excess rice production during past 6 years			Rice used as feed or exported			Rice gross exports			Rice added to stocks		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze
	Thousand metric tons														
1983	-305	-305	-305	96	96	96	36	36	36	0	0	0	-308	-308	-308
1984	204	204	204	-226	-226	-226	14	14	14	0	0	0	223	223	223
1985	1,964	685	576	-397	-397	-397	8	8	8	0	0	0	1,989	710	601
1986	2,473	1,202	986	-194	-407	-426	16	7	7	0	0	0	2,490	1,228	1,012
1987	2,796	1,701	1,396	460	35	-19	36	36	31	0	0	0	2,793	1,698	1,398
1988	2,602	1,947	1,558	1,071	463	358	1,748	175	36	400	125	0	887	1,805	1,555
1989	2,557	2,200	1,739	1,622	906	736	3,244	950	506	400	400	400	-654	1,283	1,266
1990	2,550	2,439	1,894	2,099	1,323	1,077	4,198	2,646	1,787	400	400	400	-1,615	-174	140
1991	2,592	2,687	2,062	2,490	1,696	1,358	4,980	3,392	2,716	400	400	400	-2,355	-672	-621
1992	2,598	2,918	2,210	2,595	2,029	1,606	5,190	4,058	3,212	400	400	400	-2,559	-1,107	-969

Notes: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

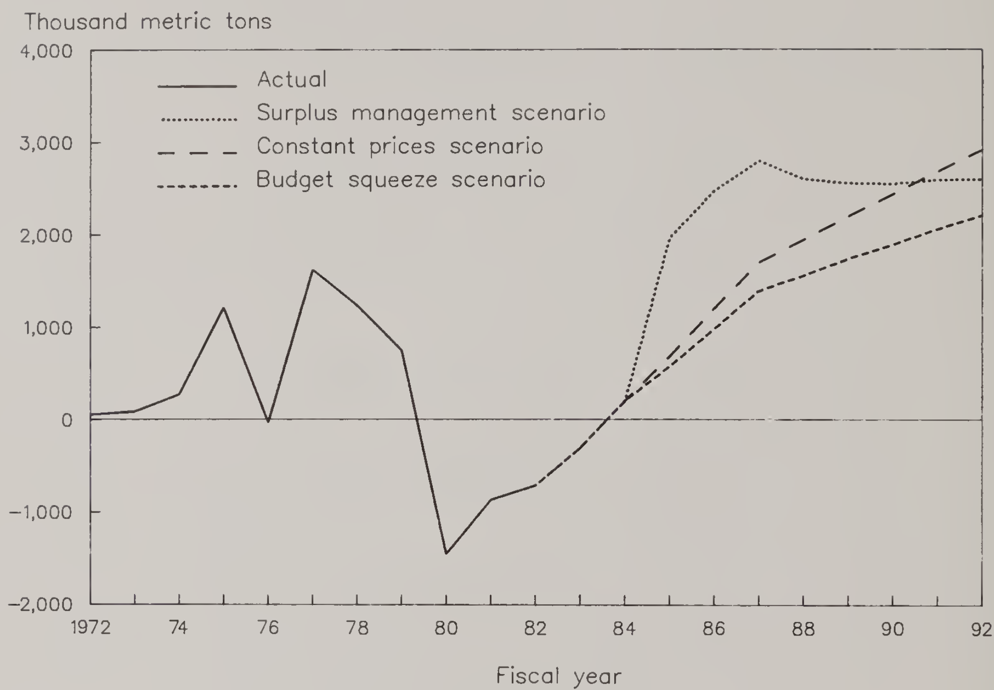
Excess rice production is defined as rice production net of seed used, minus rice used as food.

For projections of rice used as feed, see Table 8.12.

Source: Model projections.

Figure 8.39

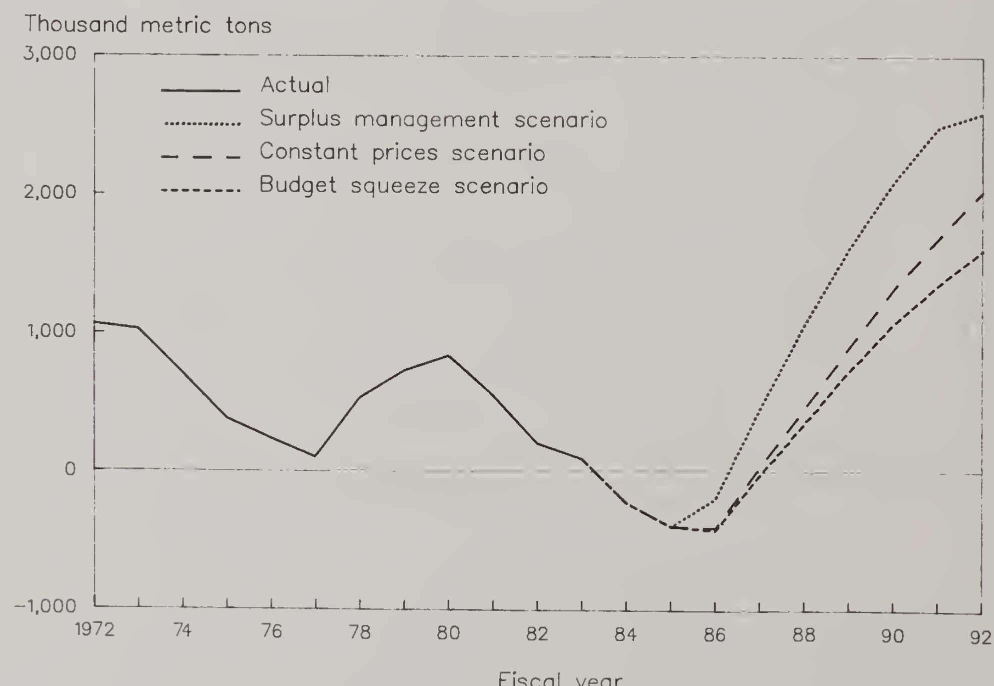
Actual and Projected Excess Rice Production



Sources: Calculated as rice production minus seed and food use, using statistics in Tables 7.2, 8.1, and 8.19.

Figure 8.40

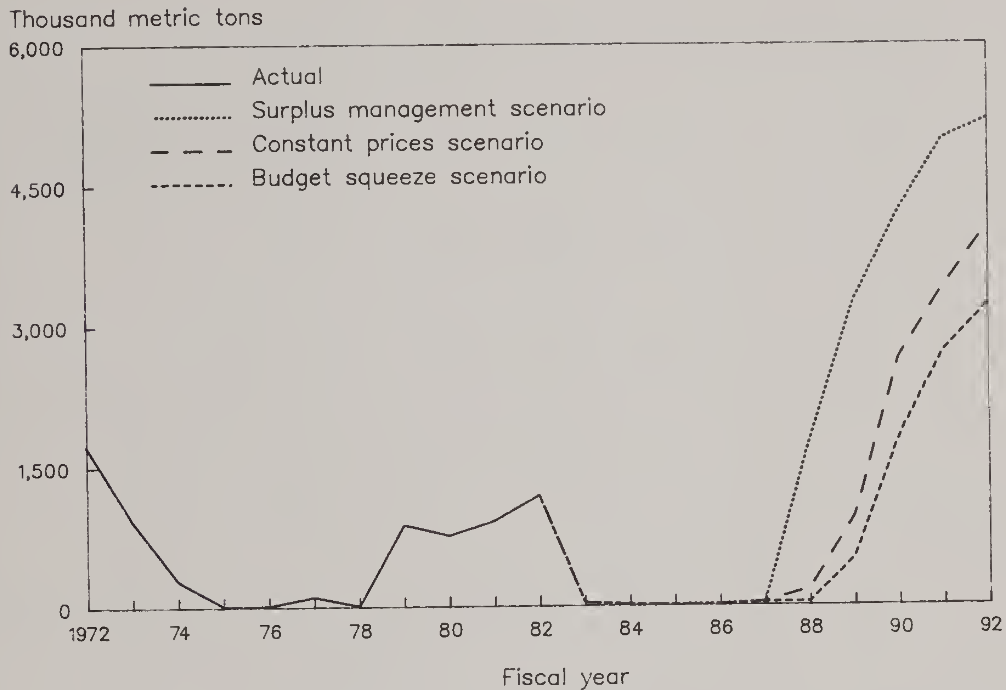
Actual and Projected Average of Excess Rice Production During Previous 6 Years



Sources: Calculated as rice production minus seed and food use, using statistics in Tables 7.3, 8.1, and 8.19.

Figure 8.41

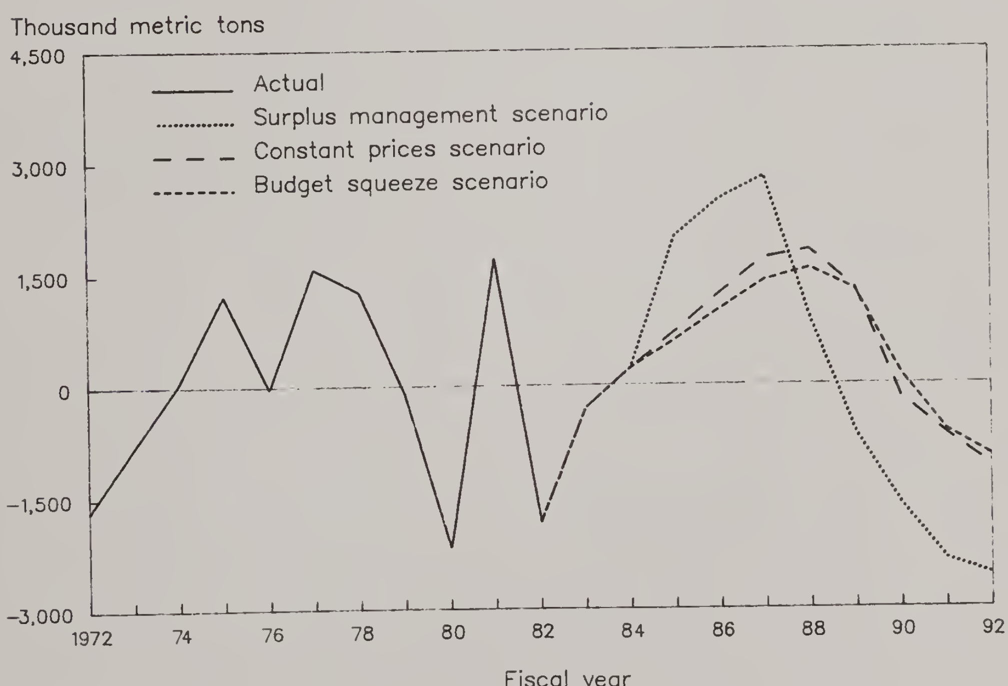
Actual and Projected Quantity of Rice Used as Feed or Exported



Sources: Derived from Tables 2.1, 8.1, and 8.19.

Figure 8.42

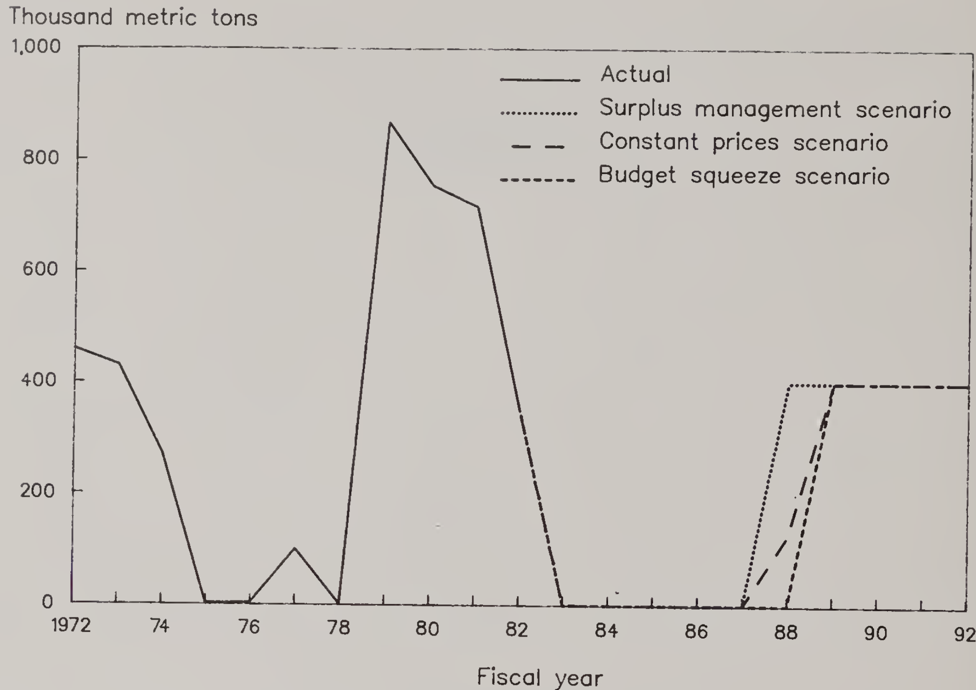
Actual and Projected Additions to Stocks of Rice



Sources: Tables 2.1, 8.1, and 8.19.

Figure 8.43

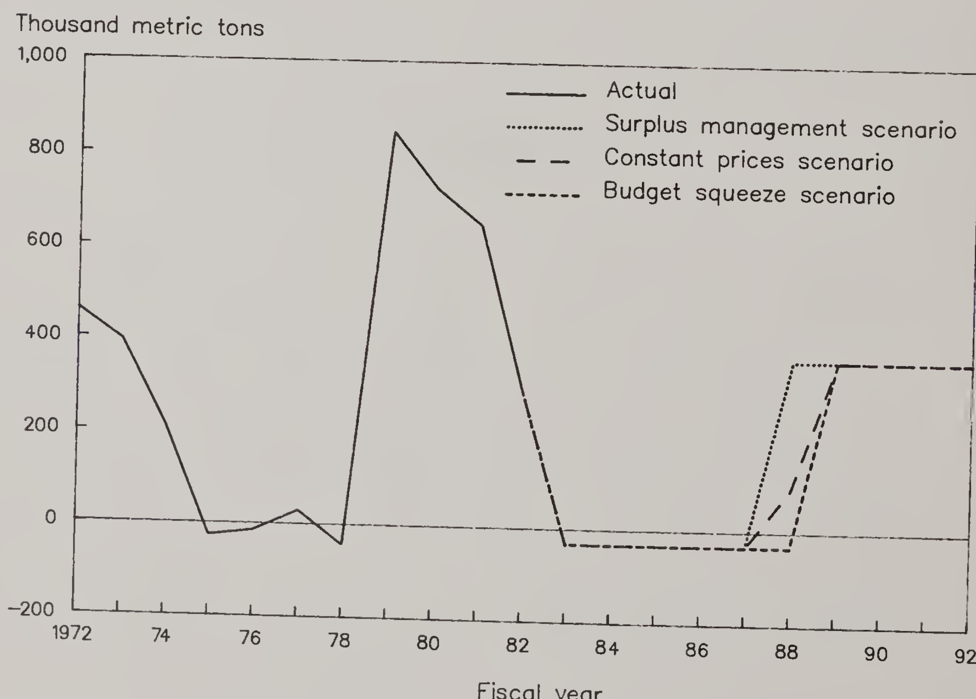
Actual and Projected Gross Exports of Rice



Sources: Tables 2.1, 8.1, and 8.19.

Figure 8.44

Actual and Projected Net Exports of Rice



Sources: Derived from Tables 6.1, 8.1, and 8.20

Table 8.20--Projected net imports of grain

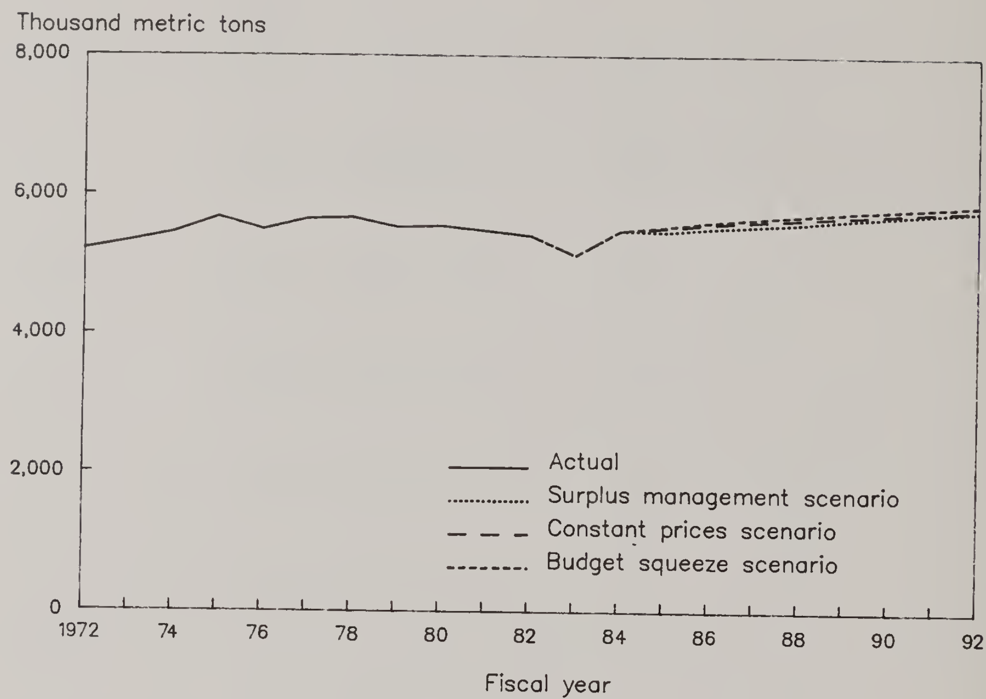
Fiscal year	Rice net imports			Wheat net imports			Corn net imports			Other coarse grain net imports			Coarse grain net imports		
	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze	Surplus management	Constant prices	Budget squeeze
	Thousand metric tons														
1983	33	33	33	5,140	5,140	5,140	12,011	12,011	12,011	8,467	8,467	8,467	20,478	20,478	20,478
1984	33	33	33	5,498	5,498	5,498	12,269	12,269	12,269	9,038	9,038	9,038	21,307	21,307	21,307
1985	33	33	33	5,480	5,536	5,552	13,607	13,607	13,607	9,409	9,455	9,466	23,016	23,062	23,073
1986	33	33	33	5,528	5,593	5,622	14,584	14,589	14,589	9,847	9,902	9,922	24,431	24,491	24,511
1987	33	33	33	5,564	5,633	5,674	15,318	15,318	15,321	10,483	10,535	10,567	25,801	25,853	25,888
1988	-367	-92	33	5,600	5,666	5,718	15,281	16,004	16,011	10,165	10,787	10,832	25,446	26,791	26,843
1989	-367	-367	-367	5,657	5,706	5,765	15,489	16,773	17,021	10,056	11,102	11,341	25,545	27,875	28,362
1990	-367	-367	-367	5,704	5,740	5,802	15,893	16,770	17,255	9,998	10,700	11,120	25,891	27,470	28,375
1991	-367	-367	-367	5,751	5,775	5,839	16,658	17,569	17,957	10,103	10,800	11,135	26,761	28,369	29,092
1992	-367	-367	-367	5,791	5,806	5,870	17,535	18,179	18,660	10,685	11,187	11,599	28,220	29,366	30,259

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Source: Model projections.

Figure 8.45

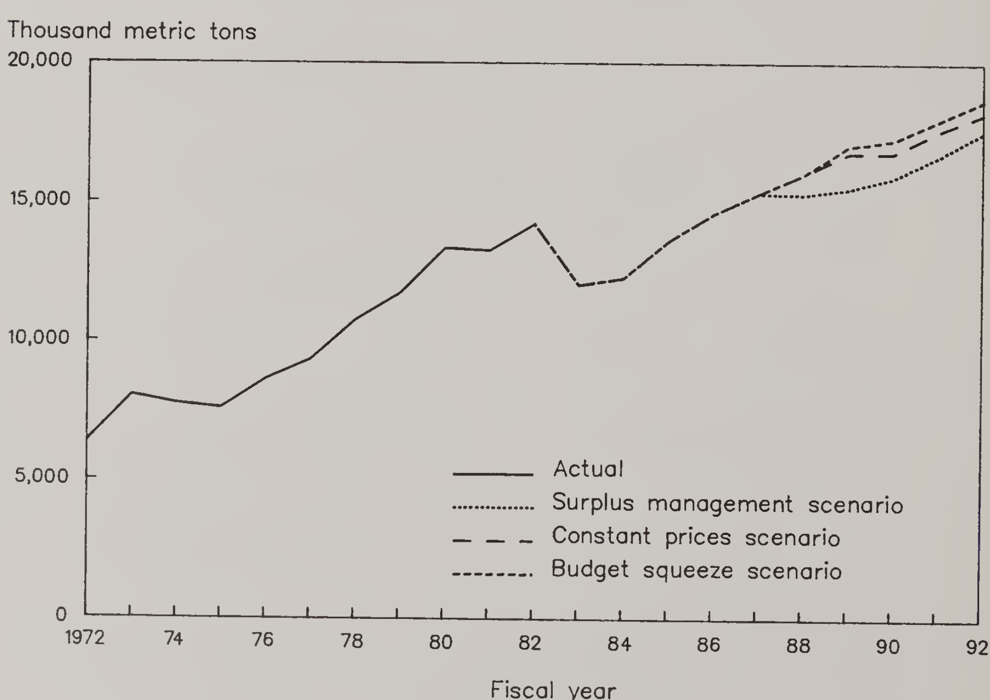
Actual and Projected Net Imports of Wheat



Sources: Derived from Tables 6.1, 8.1, and 8.20.

Figure 8.46

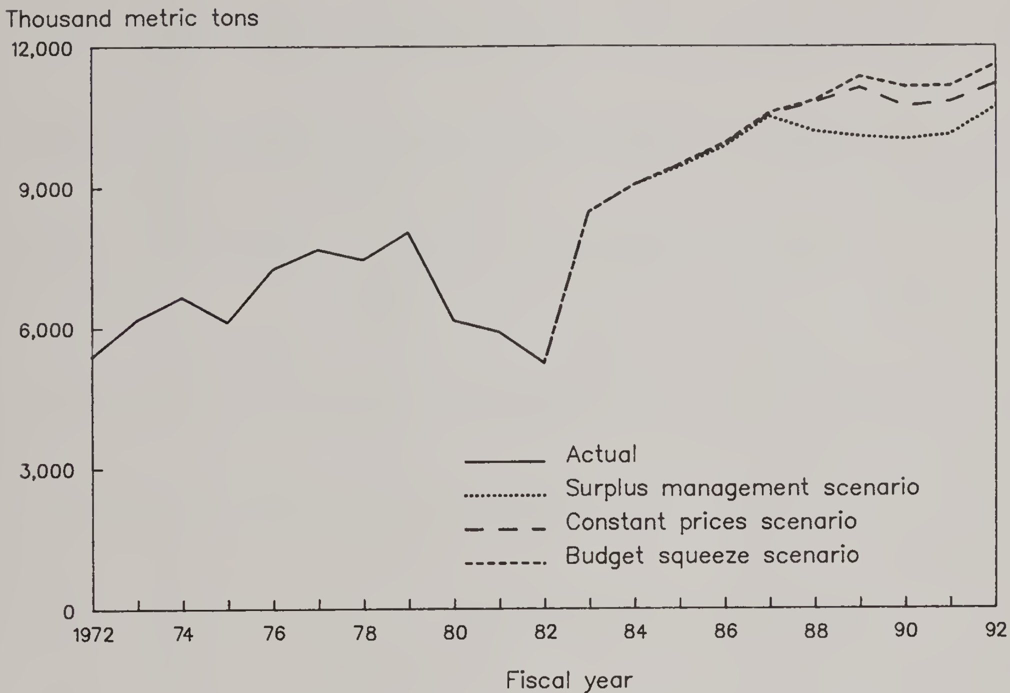
Actual and Projected Net Imports of Corn



Sources: Derived from Tables 6.1, 8.1, and 8.20.

Figure 8.47

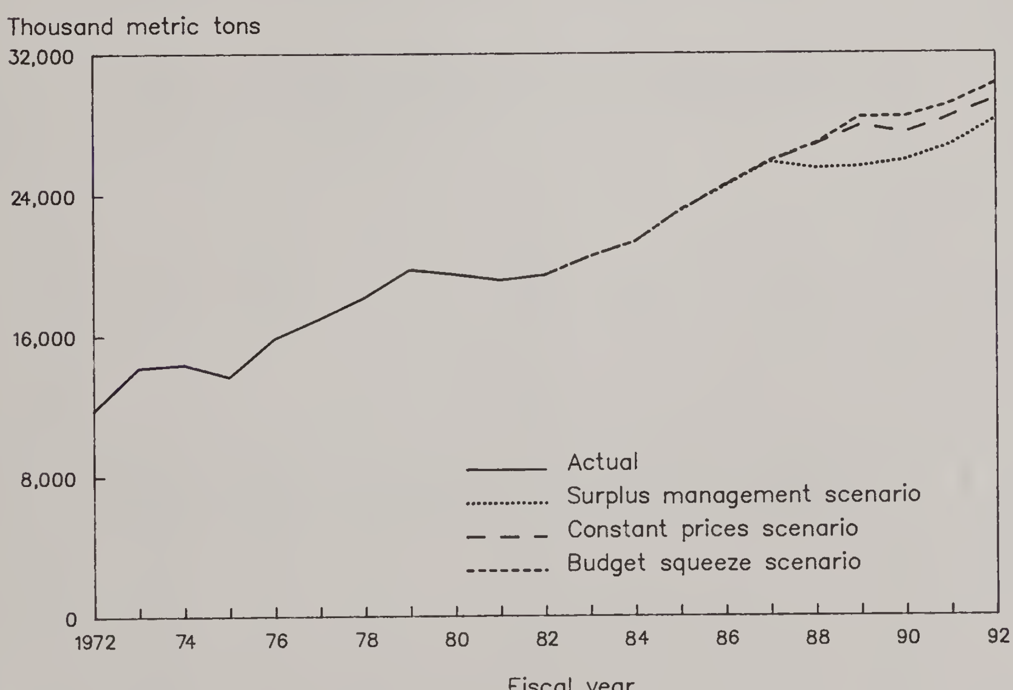
Actual and Projected Net Imports of Other Coarse Grains



Sources: Derived from Tables 6.1, 8.1 (using sum of barley and other grain), and 8.20.

Figure 8.48

Actual and Projected Net Imports of Coarse Grain



Sources: Calculated as sum of corn and other coarse grain, or as sum of barley, corn, and other grain, using statistics in Tables 6.1, 8.1, and 8.20.

Table 8.21--Projections for rice

Item ..... [Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price .... [All]	1970 yen / kilogram	25.36	26.61	25.80	25.04	25.29	26.30	26.99	25.11	24.17	24.17
[SM]		116	140	140	138	131	126	121	117	114	113
Supply price .... [CP]	- ditto -	116	116	116	116	116	116	116	116	116	116
[BS]		116	114	112	110	107	105	103	101	99	97
[SM]		193	152	137	155	235	345	488	659	843	901
Diversion payment [CP]	Thous. 1970 yen/hect.	193	193	193	193	193	193	193	193	193	193
[BS]		193	189	185	181	178	174	171	167	164	161
[SM]		511	528	666	700	721	695	675	661	649	636
Expected revenue [CP]	- ditto -	511	528	554	581	610	618	626	635	643	652
[BS]		511	528	543	558	574	570	566	562	558	555
Yield .... [All]	Metric tons/hectare	4.56	5.17	5.24	5.31	5.38	5.45	5.53	5.60	5.68	5.75
[SM]		2,273	2,074	2,356	2,390	2,389	2,293	2,223	2,166	2,116	2,065
Area .... [CP]	Thousand hectares	2,273	2,074	2,110	2,149	2,184	2,172	2,158	2,146	2,133	2,121
[BS]		2,273	2,074	2,089	2,108	2,127	2,100	2,074	2,048	2,022	1,997
[SM]		10,366	10,723	12,345	12,691	12,853	12,497	12,293	12,130	12,019	11,874
Quantity supplied [CP]	Thousand metric tons	10,366	10,723	11,056	11,411	11,750	11,837	11,934	12,018	12,115	12,196
[BS]		10,366	10,723	10,946	11,193	11,443	11,445	11,469	11,469	11,485	11,483
[SM]		78	80	93	95	96	94	92	91	90	89
Seed used .... [CP]	- ditto -	78	80	83	86	88	89	90	90	91	91
[BS]		78	80	82	84	86	86	86	86	86	86
[SM]		10,288	10,643	12,252	12,596	12,757	12,403	12,201	12,039	11,929	11,785
Supply - seed ... [CP]	- ditto -	10,288	10,643	10,973	11,325	11,662	11,748	11,844	11,928	12,024	12,105
[BS]		10,288	10,643	10,864	11,109	11,357	11,359	11,383	11,383	11,399	11,397

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

(Continues to next page)

Table 8.21 (continued)

Item ..... [Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Excess production [SM]	Thousand metric tons	-305	204	1,964	2,473	2,796	2,602	2,557	2,550	2,592	2,598
[CP]		-305	204	685	1,202	1,701	1,947	2,200	2,439	2,687	2,918
[BS]		-305	204	576	986	1,396	1,558	1,7398	1,894	2,062	2,210
Average excess production during previous 6 years [SM]	- ditto -	96	-226	-397	-194	460	1,071	1,622	2,099	2,490	2,595
[CP]		96	-226	-397	-407	35	463	906	1,323	1,696	2,029
[BS]		96	-226	-397	-426	-19	358	736	1,077	1,358	1,606
Surplus disposal [SM]	- ditto -	36	14	8	16	36	1,748	3,244	4,198	4,980	5,190
[CP]		36	14	8	7	36	175	950	2,646	3,392	4,058
[BS]		36	14	8	7	31	36	506	1,787	2,716	3,212
Food .... [All]	- ditto -	10,593	10,439	10,288	10,123	9,961	9,801	9,644	9,489	9,337	9,187
Feed .... [SM]	- ditto -	36	14	8	16	36	1,348	2,844	3,798	4,580	4,790
[CP]		36	14	8	7	36	50	550	2,246	2,992	3,658
[BS]		36	14	8	7	31	36	106	1,387	2,316	2,812
Change in stocks [SM]	- ditto -	-308	223	1,989	2,490	2,793	887	-654	-1,615	-2,355	-2,559
[CP]		-308	223	710	1,228	1,698	1,805	1,283	-174	-672	-1,107
[BS]		-308	223	601	1,012	1,398	1,555	1,266	140	-621	-969
Gross exports ... [SM]	- ditto -	0	0	0	0	0	400	400	400	400	400
[CP]		0	0	0	0	0	125	400	400	400	400
[BS]		0	0	0	0	0	0	400	400	400	400
Gross imports .. [All]	- ditto -	33	33	33	33	33	33	33	33	33	33
Net imports ..... [SM]	- ditto -	33	33	33	33	33	-367	-367	-367	-367	-367
[CP]		33	33	33	33	33	-92	-367	-367	-367	-367
[BS]		33	33	33	33	33	33	-367	-367	-367	-367

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Note: Rice statistics are on a brown basis. One unit of brown rice equals 0.906 unit of milled rice.

Source: Model projections, except underlined figures (which are actual data from Tables 8.5 to 8.8).

Table 8.22--Projections for wheat

Item	[Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price	[All]	1970 yen / kilogram	14.41	13.28	11.63	10.93	10.67	10.59	10.41	10.24	10.59	11.02
	[SM]		71	77	77	77	75	74	74	73	72	72
Supply price	[CP]	- ditto -	71	71	71	71	71	71	71	71	71	71
	[BS]		71	70	68	67	65	64	63	62	60	59
	[SM]		193	152	137	155	235	345	488	659	843	901
Diversion payment	[CP]	Thous. 1970 yen/hect.	193	193	193	193	193	193	193	193	193	193
	[BS]		193	189	185	181	178	174	171	167	164	161
	[SM]		215	211	244	249	258	260	255	249	243	238
Expected revenue	[CP]	- ditto -	215	211	224	223	226	226	226	226	226	226
	[BS]		215	211	220	212	209	201	193	186	178	171
	[SM]		3.03	3.19	3.45	3.45	3.43	3.38	3.33	3.30	3.27	3.23
Yield	[CP]	Metric tons/hectare	3.03	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
	[BS]		3.03	3.19	3.12	3.06	3.01	2.95	2.89	2.84	2.78	2.73
	[SM]		229.0	105.1	113.9	105.4	100.0	91.8	80.4	69.8	60.5	52.5
Area	[CP]	Thousand hectares	229.0	105.1	104.8	92.8	84.9	75.9	67.9	60.6	54.2	48.4
	[BS]		229.0	105.1	102.0	86.9	75.6	63.7	53.7	45.2	38.0	31.9
	[SM]		695	335	393	364	343	310	268	230	198	170
Quantity supplied	[CP]	Thousand metric tons	695	335	334	296	271	242	217	193	173	154
	[BS]		695	335	318	266	228	188	155	128	106	87
	[SM]		28	13	16	15	14	12	11	9	8	7
Seed used	[CP]	- ditto -	28	13	13	12	11	10	9	8	7	6
	[BS]		28	13	13	11	9	8	6	5	4	3
	[SM]		667	322	377	349	329	298	257	221	190	163
Supply - seed ...	[CP]	- ditto -	667	322	321	284	260	232	208	185	166	148
	[BS]		667	322	305	255	219	180	149	123	102	84
Food	[All]	- ditto -	5,299	5,329	5,359	5,382	5,404	5,427	5,449	5,472	5,495	5,517
Feed	[All]	- ditto -	508	491	498	495	489	471	465	453	446	437
Change in stocks	[All]	- ditto -	0	0	0	0	0	0	0	0	0	0
	[SM]		5,140	5,498	5,480	5,528	5,564	5,600	5,657	5,704	5,751	5,791
Net imports	[CP]	- ditto -	5,140	5,498	5,536	5,593	5,633	5,666	5,706	5,740	5,775	5,806
	[BS]		5,140	5,498	5,552	5,622	5,674	5,718	5,765	5,802	5,839	5,870

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Source: Model projections, except underlined figures (which are actual data from Tables 8.5 to 8.8).

Table 8.23--Projections for barley

Item ..... [Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Supply price .... [SM]	1970 yen / kilogram	64	70	70	70	69	68	67	66	66	65
[CP]		64	64	64	64	64	64	64	64	64	64
[BS]		64	63	62	60	59	58	57	56	55	54
Diversion payment [SM]	Thous. 1970 yen/hect.	193	152	137	155	235	345	488	659	843	901
[CP]		193	193	193	193	193	193	193	193	193	193
[BS]		193	189	185	181	178	174	171	167	164	161
Expected revenue [SM]	- ditto -	206	200	222	229	238	238	233	229	225	221
[CP]		206	200	204	206	211	211	211	211	211	211
[BS]		206	200	200	197	196	190	183	178	172	166
Yield .... [SM]	Metric tons/hectare	3.06	3.28	3.47	3.47	3.46	3.42	3.39	3.37	3.35	3.32
[CP]		3.06	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
[BS]		3.06	3.28	3.24	3.20	3.16	3.12	3.08	3.04	3.00	2.96
Area .... [SM]	Thousand hectares	124.0	99.1	98.0	92.9	87.8	79.5	69.9	61.3	53.7	47.0
[CP]		124.0	99.1	89.1	82.4	76.2	68.2	61.0	4.5	48.6	43.3
[BS]		124.0	99.1	86.8	77.7	69.3	59.3	50.7	43.3	36.9	31.4
Quantity supplied [SM]	Thousand metric tons	379	325	340	322	304	272	237	207	180	156
[CP]		379	325	292	270	250	224	200	179	159	142
[BS]		379	325	281	249	219	185	156	132	111	93
Seed used .... [SM]	- ditto -	9	8	9	8	8	7	6	5	5	4
[CP]		9	8	7	7	6	6	5	4	4	4
[BS]		9	8	7	6	5	5	4	3	3	2
Supply - seed ... [SM]	- ditto -	370	317	331	314	296	265	231	202	175	152
[CP]		370	317	285	263	244	218	195	175	155	138
[BS]		370	317	274	243	214	180	152	129	108	91
Food, direct use [All]	- ditto -	176	154	135	117	99	84	71	60	50	41
Food, indus. use [All]	- ditto -	1,178	1,253	1,333	1,415	1,503	1,596	1,695	1,800	1,911	2,030
Food, total .... [All]	- ditto -	1,354	1,407	1,468	1,532	1,602	1,680	1,766	1,860	1,961	2,071

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Source: Model projections, except underlined figures (which are actual data from Tables 8.6 to 8.8).

Table 8.24--Projections for corn

Item ..... [Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price .... [All]	1970 yen / kilogram	<u>12.44</u>	13.47	10.85	9.92	9.54	10.38	9.82	10.10	9.73	9.63
Supply - seed .. [All]	Thousand metric tons	2	1	1	1	1	0	0	0	0	0
Food .... [All]	- ditto -	2,988	3,246	3,525	3,823	4,147	4,497	4,878	5,290	5,737	6,222
Feed .... [SM]	- ditto -	9,025	9,024	10,083	10,762	11,172	10,784	10,611	10,603	10,921	11,313
[CP]		9,025	9,024	10,083	10,767	11,172	11,507	11,895	11,480	11,832	11,957
[BS]		9,025	9,024	10,083	10,767	11,175	11,514	12,143	11,965	12,220	12,438
Change in stocks [All]	- ditto -	0	0	0	0	0	0	0	0	0	0
Net imports ..... [SM]	- ditto -	12,011	12,269	13,607	14,584	15,318	15,281	15,489	15,893	16,658	17,535
[CP]		12,011	12,269	13,607	14,589	15,318	16,004	16,773	16,770	17,569	18,179
[BS]		12,011	12,269	13,607	14,589	15,321	16,011	17,021	17,255	17,957	18,660

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Source: Model projections, except underlined figure (which is an actual datum from Table 8.5).

Table 8.25--Projections for other grain

Item ...... [Scenario]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price .... [All]	1970 yen / kilogram	<u>12.04</u>	12.64	10.56	9.77	9.28	10.17	9.68	10.07	9.87	9.68
Supply - seed .. [All]	Thousand metric tons	21	19	17	15	13	12	11	9	8	8
Food .... [All]	- ditto -	144	150	156	163	169	176	184	191	199	207

Source: Model projections, except underlined figure (which is an actual datum from Table 8.5).

Table 8.26--Projections for other coarse grains

Item ..... [Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price .... [All]	1970 yen / kilogram	12.04	12.64	10.56	9.77	9.28	10.17	9.68	10.07	9.87	9.68
Supply price .... [SM]	- ditto -	64	70	70	70	69	68	67	66	66	65
[CP]		64	64	64	64	64	64	64	64	64	64
[BS]		64	63	62	60	59	58	57	56	55	54
Diversion payment [SM]	Thous. 1970 yen/hect.	193	152	137	155	235	345	488	659	843	901
[CP]		193	193	193	193	193	193	193	193	193	193
[BS]		193	189	185	181	178	174	171	167	164	161
Expected revenue [SM]	- ditto -	206	200	222	229	238	238	233	229	225	221
[CP]		206	200	204	206	211	211	211	211	211	211
[BS]		206	200	200	197	196	190	183	178	172	166
Supply - seed ... [SM]	Thousand metric tons	391	336	348	329	309	277	242	211	183	160
[CP]		391	336	302	278	257	230	206	184	163	146
[BS]		391	336	291	258	227	192	163	138	116	99
Food .... [All]	- ditto -	1,498	1,557	1,624	1,695	1,771	1,856	1,950	2,051	2,160	2,278
Feed .... [SM]	- ditto -	7,360	7,817	8,133	8,481	9,021	8,586	8,348	8,158	8,126	8,567
[CP]		7,360	7,817	8,133	8,485	9,021	9,161	9,358	8,833	8,803	9,055
[BS]		7,360	7,817	8,133	8,485	9,023	9,168	9,554	9,207	9,091	9,420
Change in stocks [All]	- ditto -	0	0	0	0	0	0	0	0	0	0
Net imports ..... [SM]	- ditto -	8,467	9,038	9,409	9,847	10,483	10,165	10,056	9,998	10,103	10,685
[CP]		8,467	9,038	9,455	9,902	10,535	10,787	11,102	10,700	10,800	11,187
[BS]		8,467	9,038	9,466	9,922	10,567	10,832	11,341	11,120	11,135	11,599

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Notes: Other coarse grains equal barley plus other grain. The trade price shown here is for sorghum; the supply price, diversion payment, and expected revenue are for barley.

Source: Model projections, except underlined figures (which are actual data from Tables 8.5, 8.6, and 8.8).

Table 8.27--Projections for coarse grains

Item	[Scenario*]	Units	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Trade price	[All]	1970 yen / kilogram	12.28	13.14	10.73	9.86	9.44	10.30	9.76	10.09	9.79	9.65
Supply price	[SM]	- ditto -	64	70	70	70	69	68	67	66	66	65
	[CP]		64	64	64	64	64	64	64	64	64	64
	[BS]		64	63	62	60	59	58	57	56	55	54
Diversion payment	[SM]	Thous. 1970 yen/hect.	193	152	137	155	235	345	488	659	843	901
	[CP]		193	193	193	193	193	193	193	193	193	193
	[BS]		193	189	185	181	178	174	171	167	164	161
Expected revenue	[SM]	- ditto -	206	200	222	229	238	238	233	229	225	221
	[CP]		206	200	204	206	211	211	211	211	211	211
	[BS]		206	200	200	197	196	190	183	178	172	166
Supply - seed ...	[SM]	Thousand metric tons	393	337	349	330	310	277	242	211	183	160
	[CP]		393	337	303	279	258	230	206	184	163	146
	[BS]		393	337	292	259	228	192	163	138	116	99
Food	[All]	- ditto -	4,486	4,803	5,149	5,518	5,918	6,353	6,828	7,341	7,897	8,500
Feed	[SM]	- ditto -	16,385	16,841	18,216	19,243	20,193	19,370	18,959	18,761	19,047	19,880
	[CP]		16,385	16,841	18,216	19,252	20,193	20,668	21,253	20,313	20,635	21,012
	[BS]		16,385	16,841	18,216	19,252	20,198	20,682	21,697	21,172	21,311	21,858
Change in stocks	[All]	- ditto -	0	0	0	0	0	0	0	0	0	0
Net imports	[SM]	- ditto -	20,478	21,307	23,016	24,431	25,801	25,446	25,545	25,891	26,761	28,220
	[CP]		20,478	21,307	23,062	24,491	25,853	26,791	27,875	27,470	28,369	29,366
	[BS]		20,478	21,307	23,073	24,511	25,888	26,843	28,362	28,375	29,092	30,259

*Scenario abbreviations: SM = surplus management. CP = constant prices. BS = budget squeeze.

Notes: Coarse grains equal corn plus other coarse grains. The trade price shown here is for a blend of 60 percent corn plus 40 percent sorghum; the supply price, diversion payment, and expected revenue are for barley.

Source: Model projections, except underlined figures (which are actual data from Tables 8.5, 8.6, and 8.8).

Excess Rice Production and the Disposal of Surplus Rice

Of central concern to Japanese agricultural policy makers is the excess of rice production over market demand. Because of poor harvests, "excess production" has been negative in recent years. Under all policy scenarios, excess rice production is projected to increase rapidly, attaining levels between 1.9 and 2.9 million metric tons in the early nineties (Table 8.19, Figure 8.39 for annual figures, and Figure 8.40 for moving average trends). The projected growth of excess production is especially quick in the surplus management scenario, because the record of negative excess production during the early eighties provokes sharp increases in the price of rice during the late eighties, which worsen the problem of surplus production then. This worsening has (only) one advantage: the earlier crisis under the surplus management scenario causes the government to take earlier countermeasures.

The government can do three things with excess rice: let it pile up in warehouses, subsidize its use as feed, or export it to the rest of the world. In each scenario, the government is depicted as letting essentially all the rice accumulate in warehouses until the late eighties. Starting in 1988 or 1989, a significant and increasing amount of rice is used as feed or exported (Figure 8.41). The policy of surplus rice disposal is implemented first and pursued most vigorously under the surplus management scenario, which in consequence is the scenario that features the earliest and deepest reduction of stocks (rice inventories start to fall in 1989). Of course, actual stock movements will depend a great deal on the unpredictable vagaries of weather--the projected stock changes shown in Figure 8.42 merely indicate trends or tendencies.

In all scenarios, gross exports of rice very quickly reach their limit and stay there (Figure 8.43). Since Japanese rice exports must be subsidized, it is reasonable to assume that they will go into food aid, not commercial channels. The remainder of surplus rice disposal is allocated to feed (Table 8.12 and Figure 8.17). By 1992, very large amounts of rice are projected to be used for feed, ranging from 2.8 million metric tons under the budget squeeze scenario to 4.8 million under the surplus management scenario. As a basis for comparison, total feed consumption in 1992 is projected at 25 million metric tons.

Net Trade

Rice net trade, starting in 1988 or 1989, is pegged to the export quota--set at 400 thousand metric tons in this model--minus annual imports of 33 thousand metric tons of specialty rice (Table 8.20 and Figure 8.44). More generally, the model projects that by 1992 the Japanese will be disbursing about 3 to 5 million metric tons of surplus rice, either as food-aid exports (which will diminish the potential for subsidized U.S. rice exports to third markets), or as feed (which will diminish the potential for commercial U.S. coarse grain exports to Japan).

Wheat net imports are projected to increase gradually and steadily from 5.4 million metric tons in 1982 to about 5.8 million metric tons in 1992, with little difference between policy scenarios (Tables 8.1 and 8.20, and Figure 8.45).

Spurred by rising feed and manufacturing demand, coarse grain net imports are expected to continue growing briskly, reaching 28 to 30 million metric tons by 1992, up from 19 million metric tons in 1982. The projections split the 1992 total into about 18 million metric tons of corn and about 11 million metric tons of other coarse grains (in practice, mainly sorghum). While the coarse grain total seems to be on track (Figure 8.48), it appears from Figures 8.46 and 8.47 that the model allocates too little of the total to corn and too much to other coarse grains. Judging from past trends, perhaps 2 or 3 million tons of projected trade should be reallocated from sorghum to corn.

APPROACHES TO REDUCING EXCESS RICE PRODUCTION

The Japanese Grains Model projects that surplus rice production will become a severe problem in the late eighties, and that in 1992 rice production will exceed market demand by 2.6 million metric tons under the surplus management scenario, 2.9 million under the constant prices scenario, or 2.2 million under the budget squeeze scenario (Table 8.21). In comparison, rice food consumption in 1992 is projected at 9.2 million metric tons. This section describes ways in which the projected surplus in 1992 might be reduced or eliminated.

The model projects rice yields as a time trend. One hope for the Japanese government is that lower prices might reduce the growth of rice yields. Regressions presented in Chapter Five show that the relationship between rice prices and rice yields is, at best, very tenuous. Nevertheless, one of the regression equations including a price term was retrieved from Table 5.30:

$$
\begin{array}{llll}
\text{JPLYDRI} = & -\ 25.781031 & +\ 0.013343036\ \text{YEAR} & +\ 0.193049\ \text{LAG1(JPLPSRI)} \\
 & \pm\ 6.064127 & \pm\ 0.002973720 & \pm\ 0.274189 \\
 & & & \\
 & (4.251) & (4.487) & (0.704) \\
 & 0.11\% & 0.07\% & 49.48\%
\end{array}
$$

Adjusted R^2 = 56.83 percent for 15 observations (JFY 1965-79)
Durbin-Watson statistic = 2.110
Autocorrelation of residuals = -0.087

JPLYDRI = Japan, logarithm of rice yield (metric tons per hectare, brown basis)

YEAR = Japanese fiscal year (values from 1965 to 1979; projected values to 1992)

JPLPSRI = Japan, logarithm of rice supply price (1970 yen per kilogram)

LAG1(x) = value of "x" lagged by 1 year

In the projections previously reported, the rice yield in 1992 equals 5.75 metric tons per hectare under all scenarios. When the influence of price is included by modeling rice yields with the equation shown above, the projected yield in 1992 is diminished slightly (to 5.55, 5.57, or 5.39 metric tons per hectare, depending on the price scenario adopted). As a result, the projections for excess production in 1992 are reduced but not eliminated: the

amounts become 2.1 million metric tons under the surplus management scenario, 2.3 million under the constant prices scenario, and 1.1 million under the budget squeeze scenario.

This leads to the question: How much would the growth rate for rice yields have to fall in order to eliminate excess rice production in 1992? Answers can be obtained by starting with the trend value for rice yield in the last year of the model's validation period (4.84 metric tons per hectare in 1979, as shown in Table 5.2), then reducing the assumed growth rate for rice yields until projected excess production in 1992 approximates zero. Under the budget squeeze scenario, the growth rate for yields would have to be cut by 80 percent after 1979, from 1.3 percent to 0.3 percent. Under the constant prices scenario, the trend growth rate would have to be cut to zero after 1979. Under the surplus management scenario, the growth rate would have to be cut by 120 percent (changing from a 1.3 percent annual increase until 1979 into a 0.3 percent annual decline after 1979). Such plunges in the trend growth rate of rice yields seem unlikely.

With rice yields modeled by the original time-trend equation, one can ask by how much prices would have to fall to eliminate excess rice production in 1992. The goal could be reached by reducing the real prices of rice, wheat, and barley by 8.6 percent per year, starting from actual prices in 1983. Other ways of attaining the target include reducing the real price of rice by 4.7 percent annually, while keeping the real prices of wheat and barley frozen at their 1983 levels; or reducing the real price of rice by 3.3 percent each year, while raising the real prices of wheat and barley by 3.3 percent. Such drastic changes in the price structure are very unlikely (although even after nine successive 8.6-percent reductions, in 1992 the supply price for rice would be about twice as high as its projected trade price, while the supply price for wheat would be about three times as high as its projected trade price).

The Japanese government is considering various plans to reform the pricing scheme for rice. Under one proposal, farmers would sell rice to the food market at a high, government-set price; but all production in excess of food demand would have to be sold to feed mills at a much lower, market-clearing price. Although this kind of program imposes severe administrative problems, 6/ it may be politically more palatable than major reductions in the official supply price.

An example of such a plan is simulated as follows. The real supply prices of food rice, wheat, and barley are frozen at their 1983 levels. All excess rice production is sold as feed, for a price 15 percent above the cost of corn in U.S. Gulf ports. It is assumed that farmers calculate expected revenue based on a "blend price", figured as a weighted average of the prices for food rice and feed rice. For instance, if one quarter of a year's rice production cannot be sold at the government-set food price, then the blend price is figured as three-fourths of the food price plus one-fourth of the feed price. The rest of the model applies without change. The simulation of this plan indicates that it would reduce--but far from eliminate--rice production in excess of food demand. In 1992, for example, rice food demand would remain at 9.2 million metric tons, production net of seed would be 11 million metric tons, and 1.8 million metric tons of excess rice production would have to be used as feed.

Finally, excess rice production could be eliminated by direct government controls on the rice area planted. Returning to the originally projected price scenarios, and assuming that land diversion would not affect average rice yields, then the fraction of riceland which would have to be diverted is the ratio of excess production to production net of seed. This implies that beyond the rice area reductions envisaged in the present set of projections, an additional 22 percent of riceland would have to be diverted to other crops under the surplus management scenario, 24 percent under the constant prices scenario, and 19 percent under the budget squeeze scenario. To the extent that farmers divert their least productive land from rice, thereby raising the average yield on what is left, even larger areas would have to be diverted in order to avoid excess rice production in 1992.

NOTES FOR CHAPTER EIGHT

1/ Problems and Prospects for U.S. Agriculture: Baseline Projections for the Farm Sector to 1992 (Economic Research Service, U.S. Dept. of Agriculture, December 1983, unpublished).

2/ Absent this floor, LIMIT1 would be a binding constraint for all levels of projected rice disposal below 36 thousand metric tons. With the floor, LIMIT1 is a binding constraint only for levels of projected rice disposal above 2,287 thousand metric tons.

3/ An 8 year span appears slightly more consistent with the 1969-82 historical record than longer or shorter horizons. Probably it would be more accurate to model government behavior as a function of the level of rice stocks, rather than the flows of supply and demand. Unfortunately, the data required to do this are not available (see Note 6 to Chapter Seven).

4/ Long-range government policy is officially outlined in MAFF, Japan's Agricultural Review, December 1980 and March 1983. The author also discussed likely trends in support prices with Suzanne Hale and Sadao Suzuki of the Agricultural Counselor's Office at the American Embassy in Tokyo; Henry Thomason, Seiji Terada, and Koichi Ito of the U.S. Feed Grains Council office in Tokyo; Keiji Oga of the Japanese National Research Institute of Agricultural Economics; Keiki Owada of the Japanese Agricultural Policy Council Expert Committee; Iichiro Takahashi of Kyushu University; Chikuji Fujitani of Kyoto Prefectural University; and others. While none of these sources gave specific price estimates, they indicated that real supply prices were likely to be stable or slowly decline through 1990.

5/ For corn there is the puzzle that seed usage exceeds production in the last two years of food balance sheet data, causing reported negative net production. The author ignores the cause of this statistical anomaly, but speculates that most corn is harvested as "green chop" for fodder, and that green chop is not counted as grain in the food balance sheets.

6/ There are two-tier price systems for milk marketing in Japan and other countries, including the United States, which could serve as precedents. These milk programs are easier to administer than the proposed rice program, because the government acts as a buyer of last resort at the lower price. Thus dairy cooperatives have an incentive to sell as much as possible to the free market, and as little as possible to the government-supported market. The rice program would encourage the opposite behavior.

☆U.S. Government Printing Office : 1986 -490-918/40389